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A comparison of monochromatic, one dimensional spectral, and two-dimensional spectral wave propagation analyses

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A COMPARISON OF MONOCHROMATIC, ONE-DIMENSIONAL SPECTRAL, AND TWO-DIMENSIONAL SPECTRAL WAVE PROPAGATION ANALYSES

by

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List of Symbols

A	scale parameter	[$L^{1/3}$]
b	wave orthogonal spacing	[L]
b_o	wave orthogonal spacing in deep water	[L]
C, C_1,C_2	wave celerity	[L/T]
C_g	wave group celerity	[L/T]
C_o	wave celerity in deep water	[L/T]
d	water depth	[L]
E	total wave energy in one wavelength per unit crest width	[F]
$\overline{E}$	total average wave energy per unit surface area	[F/L]
f	wave frequency	[1/T]
f_i	representative frequency for the ith frequency band	[1/T]
f_p	wave frequency at spectral peak	[1/T]
g	acceleration due to gravity	[L/T^2]
$G(f,\theta)$	directional spreading function	-
h	water depth at some distance y	[L]
H	wave height	[L]
H_o'	deep water wave height without refraction	[L]
H_o	deep water wave height	[L]
H_{mo}	significant wave height	[L]
H_{moi}	deep water wave height for the ith frequency band	[L]

H_{moij}	deep water wave height for the ith frequency, jth angle component	[L]
k	wave number	[1/L]
K_r	refraction coefficient	-
K_s	shoaling coefficient	-
$K_s K_r$	combined transformation coefficient	-
$(K_s K_r)_{eff}$	effective combined shoaling and refraction coefficient	-
L	wavelength	[L]
L_o	deep water wavelength	[L]
m_o	zeroth moment of a wave spectrum	[L^2]
m_{oi}	zeroth moment of the ith frequency band	[L^2]
m_{oij}	moment of the ith frequency, jth angle component	[L^2]
n	ratio of wave group celerity and wave celerity	-
s	directional spectrum spreading parameter	-
$S(f)$	frequency spectrum energy density	[L^2T]
$S(f,\theta)$	directional spectrum energy density	[L^2T]
T	wave period	[T]
x, y	horizontal coordinate directions	[L]
y	distance offshore from the mean water line	[L]
z	vertical coordinate direction	[L]
α	Phillips' scaling parameter	-
$(\Delta E)_i$	relative energy of the ith frequency component	-

$(\Delta E)_{ij}$	relative energy of the ith frequency, jth angle component	-
γ	peak enhancement factor	-
Γ	gamma function	-
λ	JONSWAP shape parameter	-
ϕ_o	three-dimensional complex velocity potential	[L/T]
ρ	fluid density	$[FT^2/L^4]$
σ	peak shape factor, angular wave frequency	- , [1/T]
θ	wave propagation direction measured from dominant direction	-

ABSTRACT

Coastal engineers carry out various projects including beach nourishment, dredging of channels and harbors, and construction of coastal structures to protect coastlines from erosion, to maintain beaches, and to preserve coastal properties. An assessment of the actual wave conditions to which these projects are subjected is required to ensure their performance. Offshore wave data is most readily available but nearshore wave data is often limited. The transformations that occur as waves propagate over irregular hydrography must be calculated to predict nearshore wave conditions. Typically a monochromatic approach is used, where a wave represented by a single representative wave height, period, and direction, is propagated into nearshore. However, this method may not be completely valid since the true sea surface, particularly for storm waves, is composed of a range of wave heights, periods, and directions. To investigate the effects of neglecting these spectral characteristics of waves, a numerical model study was conducted to simulate the propagation of monochromatic, one-dimensional spectral, and two-dimensional spectral waves over concave hydrography using RCPWAVE.

The results confirm that the process of wave transformation is sensitive to the distribution of energy within a directional spectrum as shown by the extensive range of nearshore wave heights and directions obtained for the two-dimensional spectral conditions. In particular, the propagation directions generated by the two-dimensional analyses were significantly different from the more simplified approaches. Comprehensive investigations may be required to determine wave transformation characteristics for a representative range of frequencies and directions to realistically estimate the most critical wave conditions for coastal design depending on the application. In general, preliminary estimates can be obtained through monochromatic and one-dimensional analyses. However, a two-dimensional wave propagation approach should be employed for the ultimate design to best represent wave conditions and limit the risks associated with estimation errors.

1.0 INTRODUCTION

There is little doubt regarding the critical importance of the coastal environment as over half of the U.S. population and approximately two-thirds of the world's population live within coastal regions. The increasing demand for coastal development for housing, recreation, tourism, and commerce continues to threaten the ecological and economical resources this diverse environment provides. Coastal engineers are faced with the challenge of managing and maintaining much of the coastal environment through shore protection and stabilization projects. Such design efforts require engineers to predict wave conditions at certain locations, particularly within the coastal zone. This study involves an analysis of the wave transformations that are employed to determine such wave conditions.

1.1 Coastal Engineering Consideration

A typical coastal engineering task is to determine wave conditions near the shoreline in order to design a structure and/or predict coastal processes such as erosion and deposition. Wave conditions are generally estimated for deep water or known from offshore field measurements; so representative wave heights, periods, and directions for deep water wave conditions are most commonly available. However, since deep water wave characteristics change as a wave propagates from deep to shallower water, waves must be transformed by some means into the desired nearshore location.

Significant changes in wave height and propagation direction stem from the underlying hydrography. As a wave travels from deep into shallower water, or shoals, the wave height is altered due to the relative change in water depth. Wave refraction occurs in intermediate and shallow water depths as a wave propagates over irregular hydrography changing both wave orientation and wave height. When water depth varies along the crest of a wave, the portion of the wave in shallower water will have a lower celerity. As a result, the wave crest changes direction as the wave propagates forward, attempting to become parallel with the bottom contours. The length of the wave crest is also changed causing a change in wave energy density and thus wave height.

Wave diffraction occurs when the wave height is not constant along a wave crest in order to reduce wave height variation. Energy is transmitted from points of higher to lower wave energy and height causing the wave height to adjust along the crest as the wave moves forward. An engineering analysis is required to combine the effects of shoaling, refraction, and diffraction in order to predict the resulting wave characteristics such as wave height and direction as a wave propagates from a known deep water location to a certain nearshore point of interest.

1.2 Study Objectives

A common first-order analysis used to predict nearshore wave conditions for coastal design is to select a single representative wave height, period, and direction for wave conditions at a particular site and transform this wave across the site hydrography to a nearshore water depth. However, this method, called a monochromatic wave propagation analysis, may not be completely valid considering the spectral characteristics of waves. Wave conditions for a given location are actually defined by a wave spectrum that is made up of a range of frequencies and directions. The separate components of wave spectra shoal, refract, and diffract differently as they propagate toward shore.

A wave spectrum developed from a wave record analysis requires that a large number of waves be superimposed through a Fourier analysis. One-dimensional or frequency wave spectra are based on a point measurement of the water surface time history. The energy density for all directions at a certain frequency is plotted as a function of only wave frequency to represent a one-dimensional wave spectrum. If measurements are made at more than one point or if wave gages that can measure directionality at a point are used, a two-dimensional or directional spectrum can be created. A directional wave spectrum is presented as a plot of the energy density as a function of wave frequency and direction.

The main objective of this study is to compare monochromatic, one-dimensional spectral and two-dimensional spectral wave propagation analyses to identify the effects of neglecting variations in wave frequency and direction. These three different approaches will be compared by evaluating nearshore wave conditions as defined by wave height and wave propagation direction. This investigation includes the effects of shoaling, refraction, and diffraction for waves propagating over concave hydrography.

2.0 BACKGROUND WAVE THEORY

This section focuses on the wave theory concepts that are relevant to this investigation. Specifically, the processes governing wave transformation and the wave spectra used in this study will be discussed. It is assumed that the reader has a general understanding of basic wave mechanics and is referred to Dean and Dalrymple (1984) and Sorensen (1993) for further background information on wave mechanics.

2.1 Wave Transformation

Understanding how waves transform during propagation facilitates the analyses of nearshore wave conditions. Several changes occur when waves pass through intermediate or shallow water regions, where the depth is less than half the wavelength, due to their interaction with the sea floor. As a result of the underlying hydrography, various transformation phenomena induce wave focus or attenuation and alter direction of wave propagation. This investigation incorporates three of the main processes governing the transformation of waves: shoaling, refraction and diffraction.

2.1.1 Shoaling

As monochromatic waves, or a train of waves each with the same wave height and period, propagate from deep water across a region of gradually decreasing water depth, the wavelength and celerity decrease at the same rate according to Equation 2.1.

$$C = \frac{L}{T} = \frac{gT}{2\pi}\tanh\frac{2\pi d}{L} \qquad (2.1)$$

where,

C	wave celerity
L	wavelength
T	wave period

g	acceleration due to gravity
d	water depth

At the same time, the wave height changes due to the consequent variation in the speed of energy propagation, or group celerity. This transformation of wave height caused solely by relative changes in water depth is called wave shoaling.

Neglecting surface and bottom effects and wave reflection, energy conservation principles require that energy flux remains constant as a wave propagates forward. Therefore, the energy flux at an initial deep water depth must equal the energy flux at a subsequent depth toward shore or:

$$(\overline{E}Cn)_o = (\overline{E}Cn) \tag{2.2}$$

where,

$\overline{E}$	total average wave energy per unit surface area or energy density
n	ratio of wave group celerity and wave celerity

For monochromatic waves, the total energy per unit crest width is:

$$\overline{E} = \frac{E}{L} = \frac{\rho g H^2}{8} \tag{2.3}$$

where,

E	total wave energy in one wavelength per unit crest width
ρ	fluid density
H	wave height

The subscript 'o' in Equation 2.2 denotes deep water wave conditions. From this equation, n can also be described as the fraction of energy in a wave that is transmitted forward each wave period. The value of n ranges from 0.5 for deep water to 1.0 for shallow water. By combining Equations 2.2 and 2.3, the change in wave height resulting from shoaling effects can be determined by the following equation:

$$K_s = \frac{H}{H_o'} = \sqrt{\frac{C_o}{2nC}} \tag{2.4}$$

where,

K_s	shoaling coefficient
H_o'	deep water wave height (prime denotes shoaling without refraction)
C_o	wave celerity in deep water

Since wave period remains constant and wave celerity is the propagation speed of a wave or $C = L/T$, Equation 2.4 can also be expressed in terms of wavelength as:

$$K_s = \sqrt{\frac{L_o}{2nL}} \tag{2.5}$$

where,

L_o	deep water wavelength

2.1.2 Refraction

Wave direction is also susceptible to change as waves enter regions of intermediate and shallow water depths through a transformation process called wave refraction. Waves are refracted whenever the wave crest is not parallel to the bottom contours as a result of the celerity differential along the crest. As illustrated in Figure 2.1, the wave celerity at point A, will be slower than that at point B, since the depth at A is less than the depth at B from Equation 2.1. This spatial variation of the wave celerity with respect to the crestline causes the wave crests to bend, or refract, into the pattern of the depth contours as the wave propagates forward, gradually shifting the propagation direction.

Wave refraction produced by irregular hydrography also causes wave height variation due to the convergence or divergence of wave rays. Wave rays are orthogonal lines that trace the path of travel of a wave crest from deep water toward the shore. Plots of wave rays are called refraction diagrams and indicate the direction of wave propagation and the pattern of energy distribution along a wave crest. In general, wave energy increases where orthogonals converge and decreases where they diverge. Figure 2.2 shows examples of refraction diagrams for common types of hydrography.

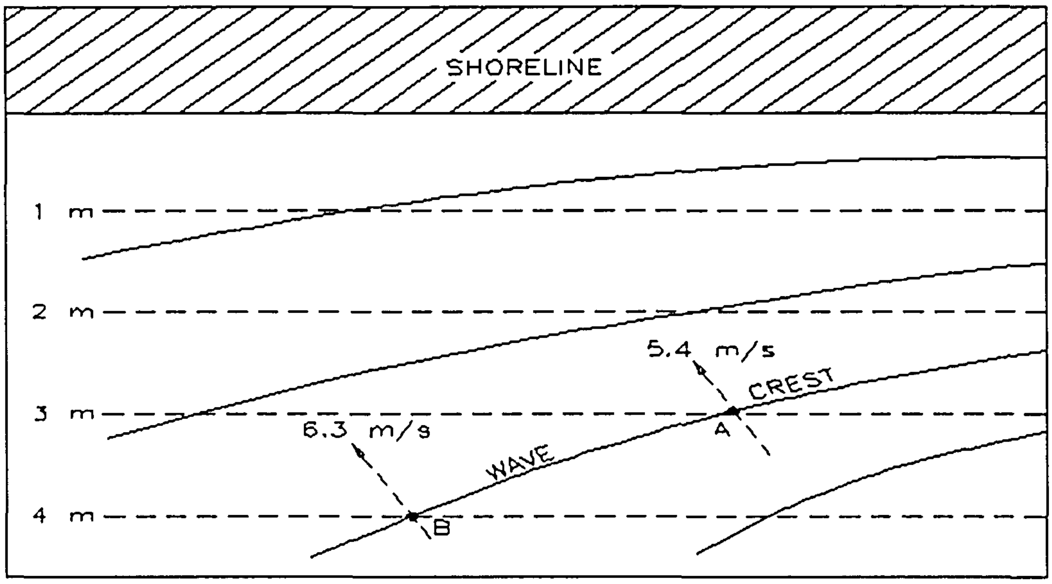

Figure 2.1. Monochromatic wave propagating across shore parallel depth contours (U.S. Army Corps of Engineers (USACE), 1984)

With the additional assumption of no energy transfer along the wave crest, the energy flux between two wave rays is conserved as a wave train propagates forward. Considering the distance between two wave rays, the energy flux relation from Equation 2.3 becomes:

$$(b\overline{E}Cn)_o = (b\overline{E}Cn) \tag{2.6}$$

where,

b_o	distance between two wave rays in deep water
b	distance between same two wave rays in region of interest

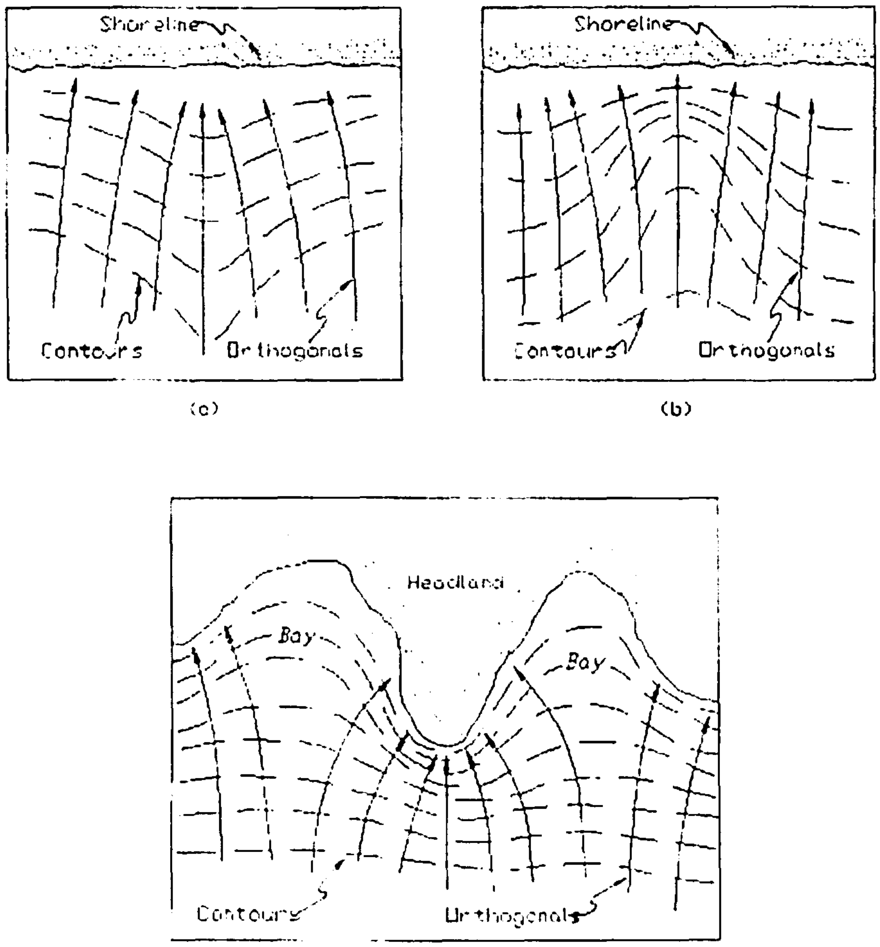

Figure 2.2. Typical refraction patterns (USACE, 1984)

By combining Equations 2.2 and 2.6, a transformation coefficient, $K_s K_r$, that describes the variation in wave height due to shoaling and refraction effects is given by:

$$\frac{H}{H_o} = \sqrt{\frac{L_o}{2nL}}\sqrt{\frac{b_o}{b}} = \frac{H}{H_o^{'}}\sqrt{\frac{b_o}{b}} = K_s K_r \tag{2.7}$$

where,

H	wave height
H_o	deep water wave height
K_r	refraction coefficient $(\sqrt{b_o / b})$
$K_s K_r$	combined transformation coefficient

The resulting increase or decrease in wave height depends on the site hydrography, approach angle, and wave period. The wave period remains constant for monochromatic waves. For wave spectra, wave height variation is also dependent upon the directional spread of energy since the energy is spread over a range of frequencies and directions. The refraction and shoaling coefficients should be considered for each frequency-direction component in order to determine the transformed spectrum since the spectral components may be affected differently by the transformation process. Wave spectra and spectral component analysis are discussed further in Section 2.2 and Chapter 4 respectively.

2.1.3 Diffraction

Wave diffraction acts to reduce wave height variation whenever the wave height is not constant along a wave crest. During this process, wave energy is transferred laterally along the crest from higher to lower waves making it possible for the wave to approach a constant wave height along its crest. Since wave refraction causes concentration or spreading of wave energy, diffraction tends to lessen these effects by moving energy away from concentrated areas.

Combining wave diffraction with refraction and shoaling is a complex wave transformation process that goes beyond the scope of wave ray analysis and requires a solution to the three-dimensional Laplace equation shown below.

$$\frac{\partial^2 \phi_o}{\partial x^2} + \frac{\partial^2 \phi_o}{\partial y^2} + \frac{\partial^2 \phi_o}{\partial z^2} = 0 \tag{2.8}$$

where,

ϕ_o	three-dimensional complex velocity potential
x, y	horizontal coordinate directions
z	vertical coordinate direction

A solution to Equation 2.8 requires appropriate surface, bottom, and lateral boundary conditions over an area of varying depths which can be a difficult theoretical problem. Berkhoff (1972) derived the mild-slope equation based on Equation 2.8 to approximately describe the complete wave transformation process for linear waves. The numerical model used in this study is based on the mild-slope equation and is discussed further in Chapter 3.

2.2 Wave Spectra

The focus of this study is a comparison of monochromatic, one-dimensional spectral, and two-dimensional spectral wave propagation. For monochromatic wave propagation analyses, waves are assumed to be sinusoidal with constant height, period, and direction. This method is commonly used in design practice since a monochromatic wave, defined by a single wave height, period, and direction, can be used to represent a more complex wave spectrum. However, this first-order analysis may not be valid considering that the true sea surface is composed of many random waves of various heights and periods, coming from many different directions.

To characterize the sea surface more realistically, a wave spectrum can be developed that describes the distribution of wave energy among different wave frequencies and directions. To investigate the effects of neglecting these spectral characteristics of waves, propagation analyses can be conducted using one-dimensional or two-dimensional spectral models that have been developed to represent more complex and realistic wave conditions. The following sections will describe the spectra models used in this study.

2.2.1 One-dimensional (Frequency) Spectra

The sea surface is analyzed by assuming it is composed of an infinite number of individual wave components each having different frequencies and directions and determining the resulting wave spectrum or distribution of wave energy with respect to frequency and direction.

A wave record or time trace of the water surface profile is converted into a wave spectrum by superimposing a multitude of component sine waves that have different periods, amplitudes, phase positions, and propagation directions. A one-dimensional or frequency spectrum is created by plotting the total energy density of these wave components at each frequency without considering direction. The result is a continuous curve of wave energy density, $S(f)$, versus frequency and is expressed mathematically employing the relationship from Equation 2.3.

$$S(f)df = \sum_{f}^{f+df} \frac{H^2}{8} \tag{2.8}$$

where,

f	wave frequency $(1/T)$
$S(f)$	frequency spectrum energy density

The actual scale and shape of a frequency spectrum for the sea surface depends on several factors including the fetch length and width as well as wind speed and duration. Several spectral models have been developed from empirical fits of wave measurements to predict the expected wave spectrum for different generating factors or wave parameters. The spectral model used in this study is the JONSWAP (Joint North Sea Wave Project) spectrum, developed by Hasselmann et al. (1973), which is commonly used in practice for wave forecasting projects. Wave and wind measurements were taken in the North Sea to produce a deep water fetch-limited model spectrum. The JONSWAP spectrum is expressed as

$$S(f) = \frac{\alpha g^2}{(2\pi)^4 f^5} e^{-\left[1.25\left(\frac{f_p}{f}\right)^4\right]} \gamma^{e^{-\left[\frac{(f-f_p)^2}{2\sigma^2 f_p^2}\right]}} \tag{2.9}$$

where,

α	Phillips' scaling parameter
f_p	wave frequency at spectral peak
γ	peak enhancement factor (controls sharpness of the spectral peak)
σ	peak shape factor (controls width of spectral peak)

The mean values for the shape parameters, γ and σ, determined for the North Sea are utilized in this investigation and are:

$$\begin{aligned}&\gamma = 3.3\\ &\sigma = 0.07 \quad \text{when} \quad f < f_p\\ &\sigma = 0.09 \quad \text{when} \quad f \geq f_p\end{aligned}$$

To generate a JONSWAP spectrum for a certain significant wave height and peak frequency, Equation 2.10 developed by Mitsuyasu (1980) is used to determine the remaining scaling parameter, α. Tucker (1991) contains a full discussion of the development of this relationship.

$$H_{mo} = 4g(\alpha\lambda)^{1/2} f_p^{-2} \tag{2.10}$$

where,

H_{mo}	significant wave height
λ	JONSWAP shape parameter

The recommended value for λ is 0.000196 which corresponds to the mean JONSWAP parameter values listed above. The values used for the significant wave height, H_{mo}, Phillips' scaling parameter, α, and the resulting JONSWAP spectra are discussed in Chapter 4.

2.2.2 Two-dimensional (Directional) Spectra

A frequency spectrum alone is not sufficient for describing natural ocean waves since the individual components propagate in various directions. To include wave directionality in a spectrum, directional wave components are superimposed to show the wave energy distribution with respect to both frequency and direction. A two-dimensional or directional wave spectrum is generated by plotting the energy density in these component waves at each frequency against both wave frequency and propagation direction. Similar to Equation 2.8, a directional wave spectrum is expressed as:

$$S(f,\theta)dfd\theta = \sum_{f}^{f+df}\sum_{\theta}^{\theta+d\theta}\frac{H^2}{8} \tag{2.11}$$

where,

θ	wave propagation direction measured from dominant direction
$S(f,\theta)$	directional spectrum energy density

Figure 2.3 is shows a one-dimensional frequency spectrum and a one-dimensional direction spectrum, which are combined to yield a two-dimensional, directional wave spectrum. It is apparent from Figure 2.3 that the wave energy is concentrated at the dominant directions for the frequencies near the spectral peak.

Directional spectral models have been developed from directional spectral data obtained from the use of wave gages that can identify directionality of a wave field at a certain location. Typically, a one-dimensional frequency spectrum is modified by a spreading function that depends on wave frequency and direction to determine the directional spread of energy with respect to frequency. The resulting two-dimensional spectrum is expressed as:

$$S(f,\theta) = S(f)\cdot G(f,\theta) \tag{2.12}$$

where,

$G(f,\theta)$	directional spreading function

This dimensionless spreading function represents the relative magnitude of directional spreading of wave energy. Therefore, the total energy density in the two-dimensional spectrum must be the same as that corresponding to the one-dimensional spectrum, and by definition:

$$\int_{-\pi}^{\pi} G(f,\theta)d\theta = 1$$

Two directional spreading functions that are commonly used by the U.S. Army Corps of

Engineers (CETN-I-28, 1985) are the cosine-squared function and the Mitsuyasu function. Both are employed in this investigation.

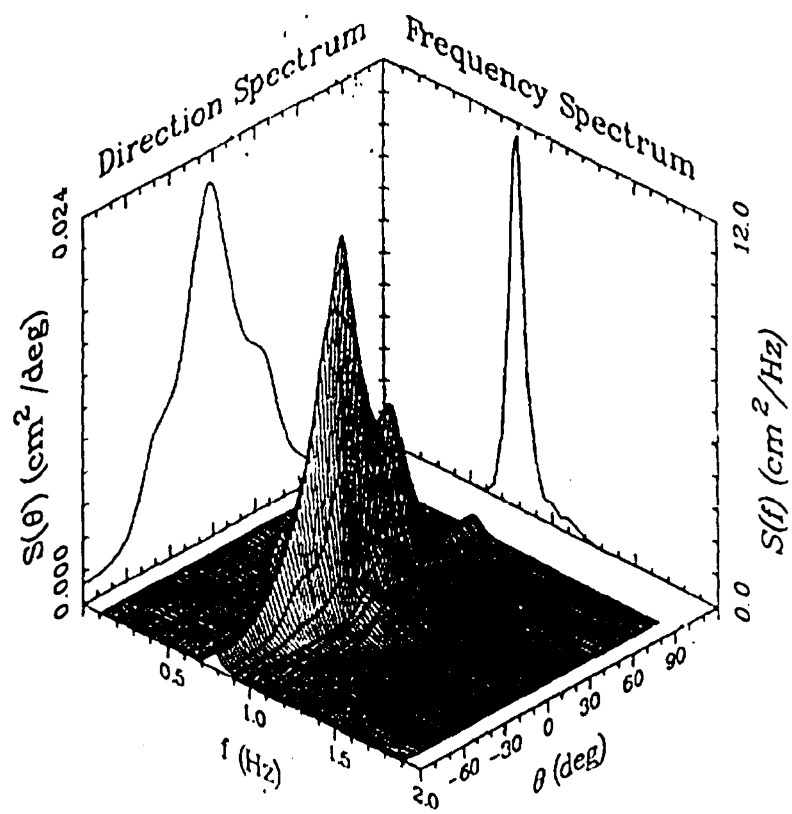

Figure 2.3. A two-dimensional spectrum and its frequency and direction spectrum (USACE, 1984)

The cosine-squared function, originally developed by St. Dennis and Pierson (1953), is independent of frequency and is expressed as:

$$G(f,\theta) = G(\theta) = \frac{2}{\pi}\cos^2\theta \tag{2.13}$$

where θ represents the wave direction in radians varying from $-\pi/2$ to $\pi/2$. Figure 2.4 illustrates how the cosine-squared spreading function distributes the spectral energy distribution with respect to variation in wave direction for a hypothetical JONSWAP spectrum. As the wave direction deviates from the mean propagation direction, the spectral energy density changes in magnitude only.

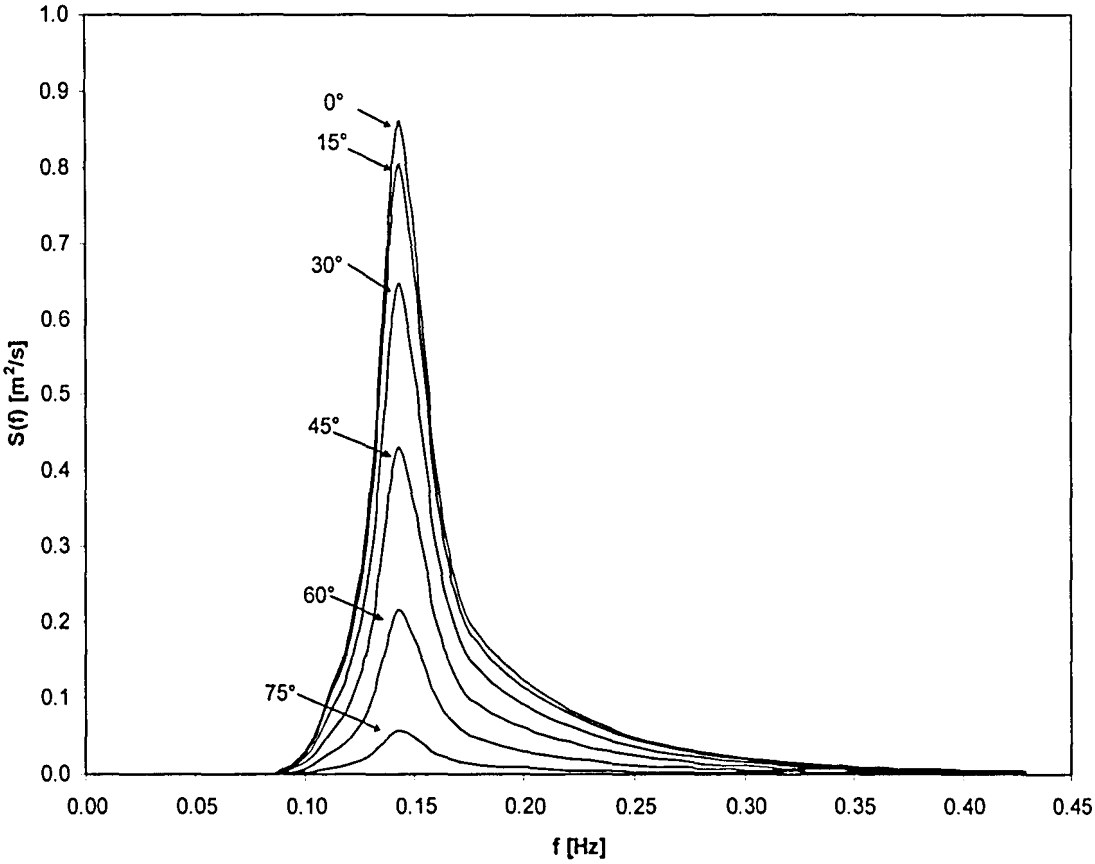

Figure 2.4. Example of cosine-squared spreading function applied to a JONSWAP spectrum

A more complex and commonly used spreading function is the Mitsuyasu function which is based on field measurements with a cloverleaf-type directional wave gauge from Mitsuyasu et al. (1975). The Mitsuyasu function is:

$$G(f,\theta)=\frac{2^{2s-1}}{\pi}\frac{\Gamma^2(s+1)}{\Gamma(2s+1)}\cos^{2s}\left(\frac{\theta}{2}\right) \tag{2.14}$$

where,

s	directional spectrum spreading parameter
Γ	gamma function

The mathematical gamma function is the generalized factorial function and is defined by the following integral:

$$\Gamma(z) = \int_{0}^{\infty} t^{z-1} e^{-t} dt$$

This function can be determined for specific values from references that tabulate mathematical functions or through the use of various mathematical software programs.

The directional spreading parameter, s , represents the degree of directional energy concentration. It reaches a maximum value at the spectral peak frequency and decreases as the frequency moves away toward either higher or lower frequencies. Goda and Suzuki (2000) simplified this parameter by defining it in terms of frequency, spectral peak frequency and a maximum value, $s_{\max}$.

$$s = s_{\max}(f / f_p)^5 \quad \text{when } f < f_p$$
$$s = s_{\max}(f / f_p)^{-2.5} \quad \text{when } f > f_p$$

Mitsuyasu et al. (1975) empirically determined values for $s_{\max}$ from observations and showed that $s_{\max}$ varies with generating factors and wave steepness. Goda (2000) recommends an average $s_{\max}$ value of 25 for swell with a short decay distance and relatively large wave steepness.

Figure 2.5 depicts the Mitsuyasu spreading function as a function of direction for various frequencies (relative to peak frequency) for a given $s_{\max}$. In contrast to the cosine-squared function, the spectral energy density changes with respect to both frequency and direction affecting both the magnitude and shape of the spectrum.

Through the use of Equations 2.12-2.14, a two-dimensional wave spectrum can be generated from a JONSWAP spectrum for different wave conditions. Since initial wave characteristics such as wave period, direction, and distribution of energy with respect to frequency and direction affect the degree to which wave height and direction are impacted, the transformation of individual spectral components must be analyzed for both the one-dimensional and two-dimensional wave spectra. These spectral component analyses will be addressed in Chapter 4.

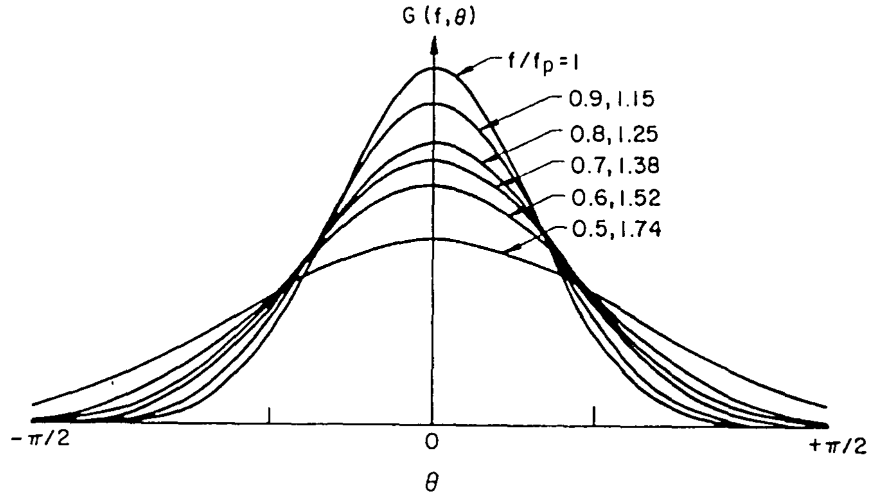

Figure 2.5. Mitsuyasu spreading function versus direction and normalized frequency for a given s_{max} (Sorensen, 1993)

3.0 NUMERICAL APPROACH: RCPWAVE

The Regional Coastal Processes Wave (RCPWAVE) propagation model is a two-dimensional steady-state, finite difference model that simulates wave propagation over arbitrary site hydrography outside the surf zone. The model accounts for shoaling, refraction, and diffraction caused by variable water depths. RCPWAVE solves finite difference approximations of its governing equations to model linear, monochromatic waves propagating over a mild bottom slope. The original version of this model, used in this study, was developed in the early 1980s by USACE and involves rigid ASCII input/output formats. The current version of RCPWAVE is now available in a Windows-based interface as a part of the Coastal Engineering Design and Analysis System (CEDAS) used by the USACE Coastal Hydraulics Laboratory (CHL). Further information regarding this software is available on the CHL web page at http://chl.wes.army.mil/software. The purpose of this chapter is to describe the theoretical basis and operation of RCPWAVE. The Coastal Modeling System (CMS) User's Manual (Cialone et al. 1991) provides further detail.

3.1 Assumptions and Limitations

RCPWAVE is a steady state model that simulates wave propagation using linear, monochromatic wave theory and therefore, does not describe nonlinear, time-dependent effects or irregular waves. The model assumes that wave reflection and energy losses outside of the surf zone are negligible. Applications of RCPWAVE are restricted to mild bottom slopes, maximum wave angles of +/- 86°, and open coast areas since it does not model the effects of structures.

Based on these assumptions and limitations, RCPWAVE simulates monochromatic wave propagation including the effects of shoaling, refraction, and bottom-induced diffraction due to irregular bottom configurations. A spectral representation of wave conditions is assumed to be adequately simulated in RCPWAVE by using an equivalent monochromatic wave approach, i.e.

significant wave height, peak spectral period, and mean direction.

3.2 Wave Transformation Equations

RCPWAVE is based on the mild-slope equation that was developed by Berkhoff (1972). The mild-slope equation is a two-dimensional, elliptical partial differential equation that approximates the complete wave transformation process, including shoaling, refraction and diffraction, for linear, monochromatic waves propagating over arbitrary hydrography and is expressed as:

$$\frac{\partial}{\partial x}\left(CC_g \frac{\partial \phi_o}{\partial x}\right) + \frac{\partial}{\partial y}\left(CC_g \frac{\partial \phi_o}{\partial y}\right) + \sigma^2 \frac{C_g}{C}\phi_o = 0 \qquad (3.1)$$

where,

σ angular wave frequency ($2\pi / T$)

Berkhoff derived Equation 3.1 by integrating a two-dimensional form of the Laplace equation, Equation 2.8, over water depth and employing a linearised free-surface boundary condition, a mildly sloping bottom boundary condition, and a complex velocity potential of the form:

$$\phi_o(x, y) = \frac{gH(x, y)}{2\sigma}\Phi\left(\frac{\cosh k(d+z)}{\cosh kd}\right)$$

The velocity potential, ϕ_o, can be separated into a forward-scattered and a reflected component. RCPWAVE solves a simplified version of Equation 3.1, where the velocity potential only describes the forward-scattered wave field.

Equation 3.1 is based on linear wave theory which assumes irrotationality of the wave phase function gradient also known as the wave number, k. This irrotationality condition requires that the curl of the gradient equal zero, i.e.:

$$\frac{\partial(k \sin\theta)}{\partial x} - \frac{\partial(k \cos\theta)}{\partial y} = 0 \qquad (3.2)$$

where,

k wave number ($2\pi / L$)

Equations 3.1 and 3.2 are the governing equations solved by RCPWAVE to calculate local wave heights and angles for a given offshore wave climate.

3.3 Solution Method

Finite difference approximations of the governing partial differential equations are solved through a computational grid composed of rectangular grid cells similar to that shown in Figure 3.1. The grid system is oriented with the x-axis perpendicular to the shoreline in the offshore direction and with the y-axis along the shoreline. Solutions for the wave height, direction, and wave number at the center of each grid cell are obtained using a forward-marching solution scheme in the direction of propagation.

To solve the finite difference equations, RCPWAVE estimates initial values for the variables of interest at each grid cell by implementing the following procedure:

1. The wave number, k, is calculated at every grid cell using the dispersion relation, Equation 2.1.
2. The wave celerity, C, and group celerity, C_g, are calculated at each grid cell since they are functions of the wave period and wave number.
3. The local wave angle, θ, is estimated throughout the grid using Snell's Law:

$$\frac{\sin\theta_1}{C_1} = \frac{\sin\theta_2}{C_2}$$

where '1' and '2' represent the conditions at locations 1 and 2, respectively.

4. Initial estimates of the wave height, H, at each grid cell are calculated using Equation 2.7 which states that it is the product of the deep water wave height, H_o, the shoaling coefficient, K_s, and the refraction coefficient, K_r.

Once these initial estimates are established, an iterative finite difference process is used to solve Equations 3.1 and 3.2 for the final wave heights, numbers, and angles throughout the grid. Computation begins along the offshore row where calculations are repeated until a solution, meeting a certain convergence criterion, for wave height, direction, and number is determined for each grid cell in the row. RCPWAVE repeats this process for the next consecutive row and continues row by row until reaching the last row at the shoreline.

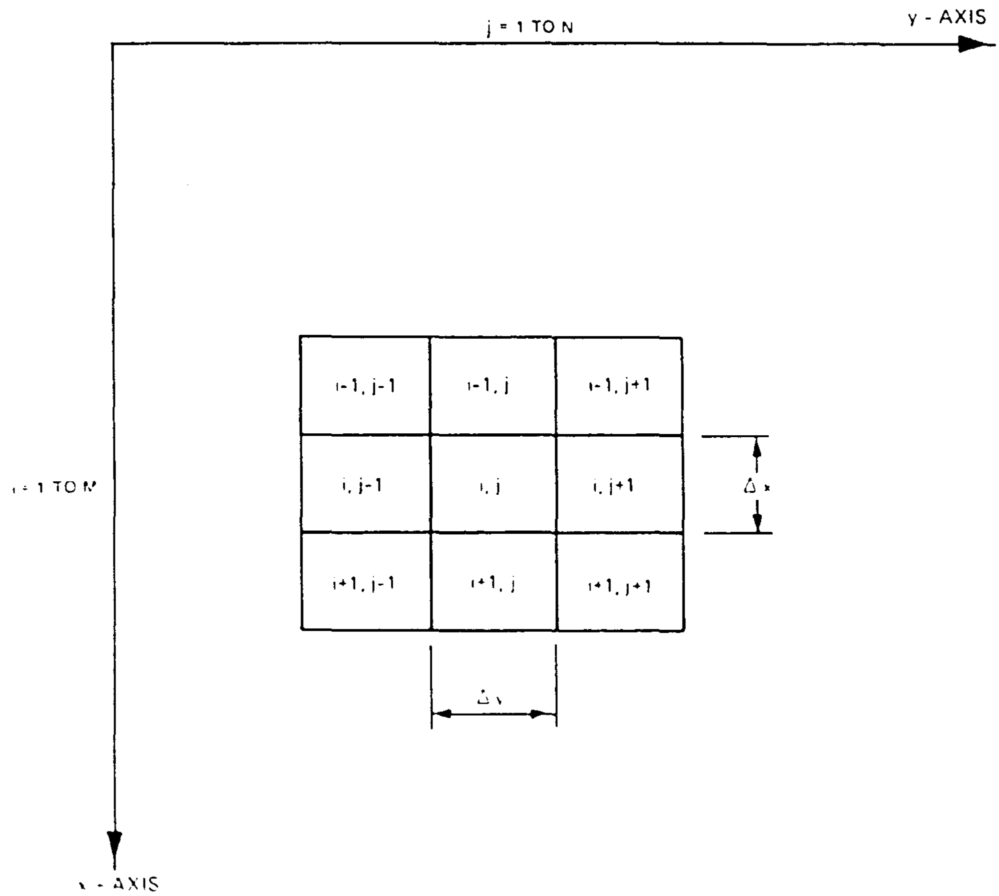

Figure 3.1. Computational grid convention for RCPWAVE (Cialone et al., 1991)

3.4 Input Requirements

RCPWAVE requires input for deep water wave conditions and site hydrography. Since the model simulates monochromatic wave propagation, the wave climate along the offshore boundary of the RCPWAVE computational grid is defined by a single deep water wave height, H_o, direction, θ_o, and period, T. Wave angles are defined in RCPWAVE by the convention shown in Figure 3.2.

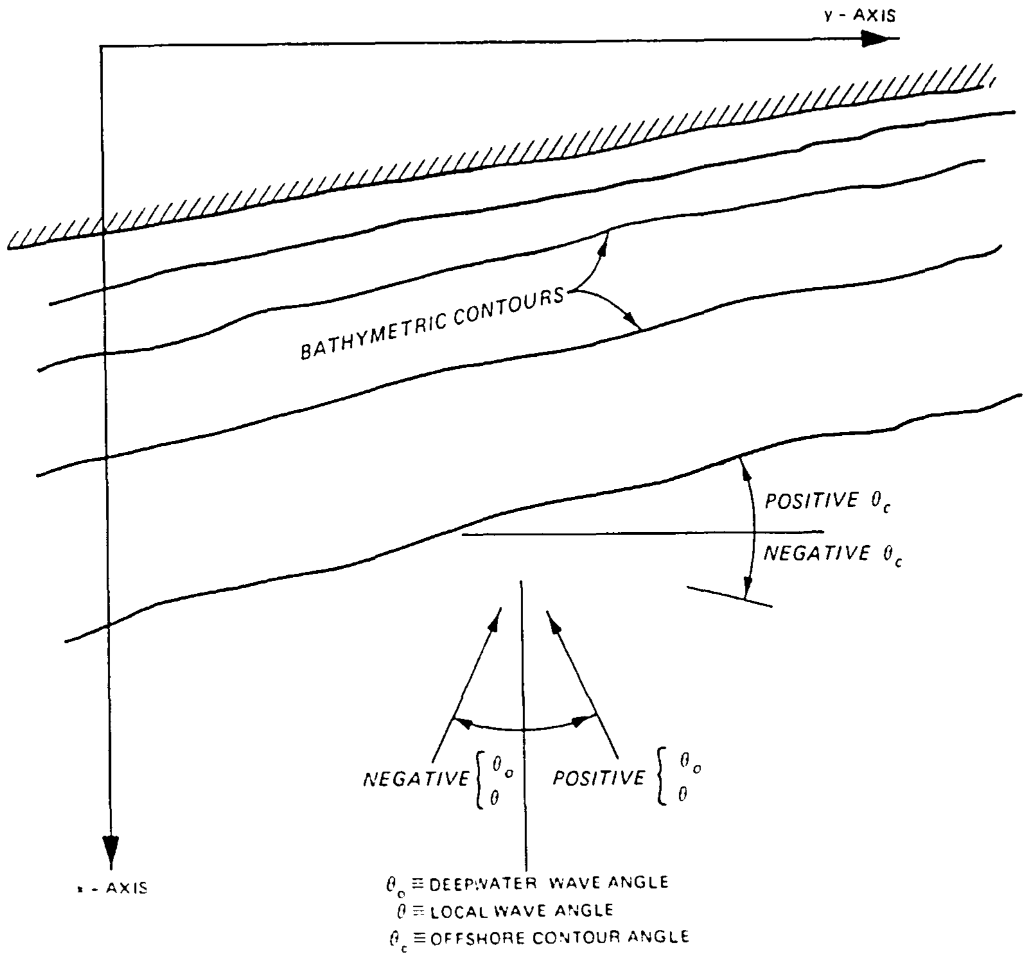

Figure 3.2. Wave angle conventions used in RCPWAVE (Cialone et al., 1991)

Detailed site hydrography requires water depth values for every grid cell. The user also has the option of specifying a certain nearshore reference line for which the results are written to a separate output file. A sample input data set for RCPWAVE is given in Appendix A.

3.5 Program Output

An RCPWAVE output file contains wave heights, propagation directions, and wave numbers for a specified block of grid cells. These numerical results are reported to two decimal places. If the user specifies a nearshore reference line as discussed above, the wave heights, angles, and depths for these grid cells only are written to a separate output file with a four decimal place accuracy. Samples of these two output files are shown in Appendix A and correspond to the sample input file from Section 3.4.

4.0 EXPERIMENTAL CONDITIONS

Information describing a specific test site is required to simulate wave propagation. More specifically, the site hydrography and offshore wave characteristics must be established to run the model. This chapter details the experimental conditions used in this analysis to represent a typical coastal environment.

4.1 Site Hydrography

An empirical beach profile equation, introduced by Bruun (1954), was used to create the hydrography for the hypothetical test area. This empirical relationship is based on measurements taken along the Danish north coast and Mission Bay, California and is confirmed by more recent field investigations conducted in Florida and the island of St. Martin. Work (1991) provides a complete discussion of these studies. The field data shows that beach profiles are generally well-represented by:

$$h(y) = Ay^{2/3} \tag{4.1}$$

where,

y	distance offshore from the mean water line
h	water depth at some distance y with respect to the mean water line
A	scale parameter depending on sediment characteristics

Moore (1982) and Dean (1987) established the relationship shown in Figure 4.1 between the scale parameter, A, and sediment diameter and fall velocity from numerous beach profile measurements. The most familiar beaches are those with shorelines composed of sand grains ranging in size from 0.1 mm for very fine sand to 2 mm for very coarse sand. A sediment diameter of 0.5 mm, classified as medium to coarse sand (Komar, 1998), yields a value of 0.125 $m^{1/3}$ for A from the suggested relationship in Figure 4.1.

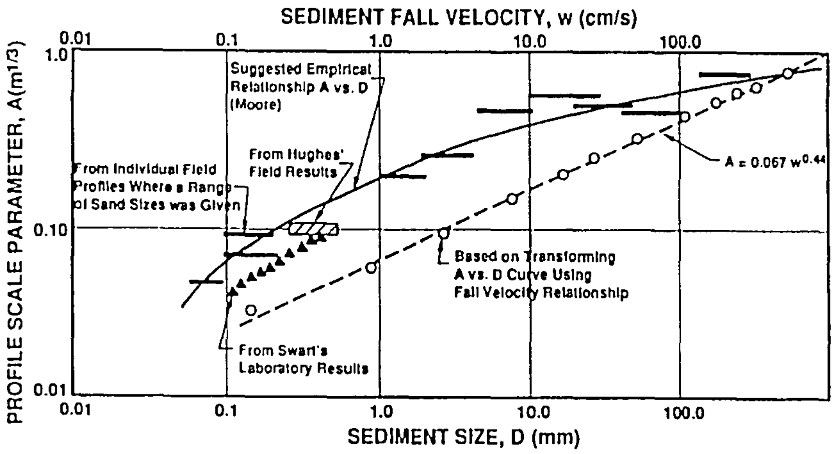

Figure 4.1. Beach profile factor, A, versus sediment diameter and fall velocity (Work, 1991)

The beach profile generated from Equation 4.1 for this investigation is shown in Figure 4.2. The profile extends from the still water line to deep water, where the depth is 78 m at an offshore distance of 15,600 m. Deep water is defined as the location where the depth reaches half the wavelength. Since wavelength and deep water depth increase with period, the deep water depth was calculated for the maximum wave period of 10 s used in this study.

A grid system defining the experimental area was developed based on the beach profile information above since RCPWAVE solves through a computational grid. The experimental grid consists of 39 cells in the alongshore direction, y, and 39 cells in the offshore direction, x, with a constant grid cell spacing of 400 m. The resulting grid is 15,600 m by 15,600 m and covers a total offshore area of approximately 244 km^2.

Sinusoidal curves of varying amplitudes were used to create concave water depth contours. A total of six contours were superimposed over the grid to represent the overall experimental hydrography. The beach profile data from Figure 4.1 was used to assign specific depths to each contour based on the distance offshore along the centerline of the grid (y = 20). Water depth values for the remaining grid cells were obtained through interpolation and are included in the sample input file from Appendix A.

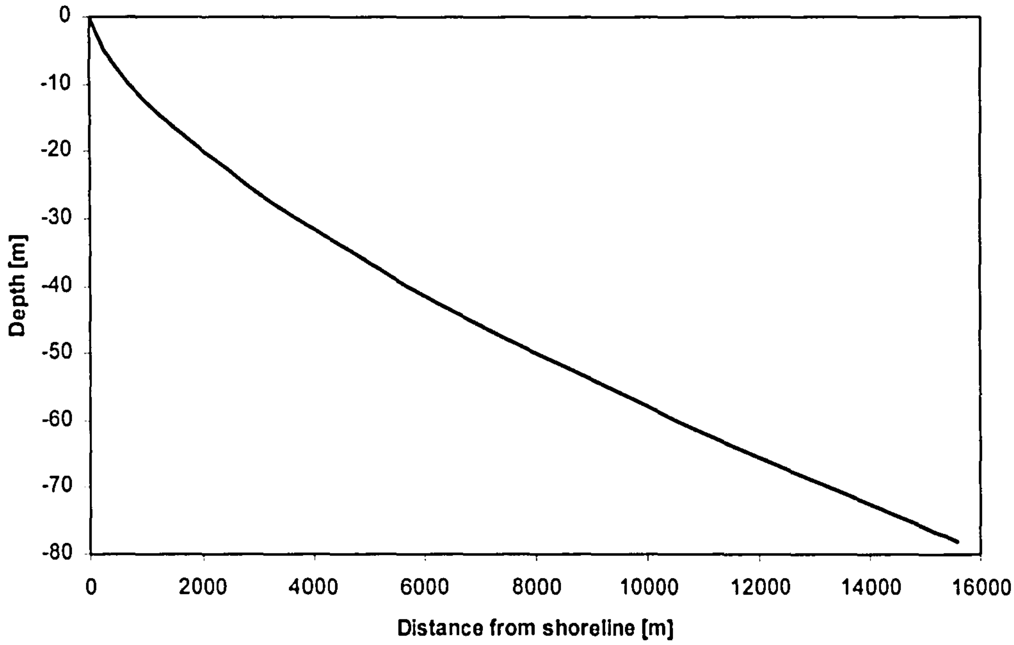

Figure 4.2. Experimental beach profile for 0.5 mm sediment diameter

The experimental grid and resulting depth contours are shown in Figure 4.3. Each contour is labeled by a number which corresponds to a water depth in m. Letters A through D shown in Figure 4.3 represent the nearshore sites selected for analysis and are discussed further in Chapter 5.

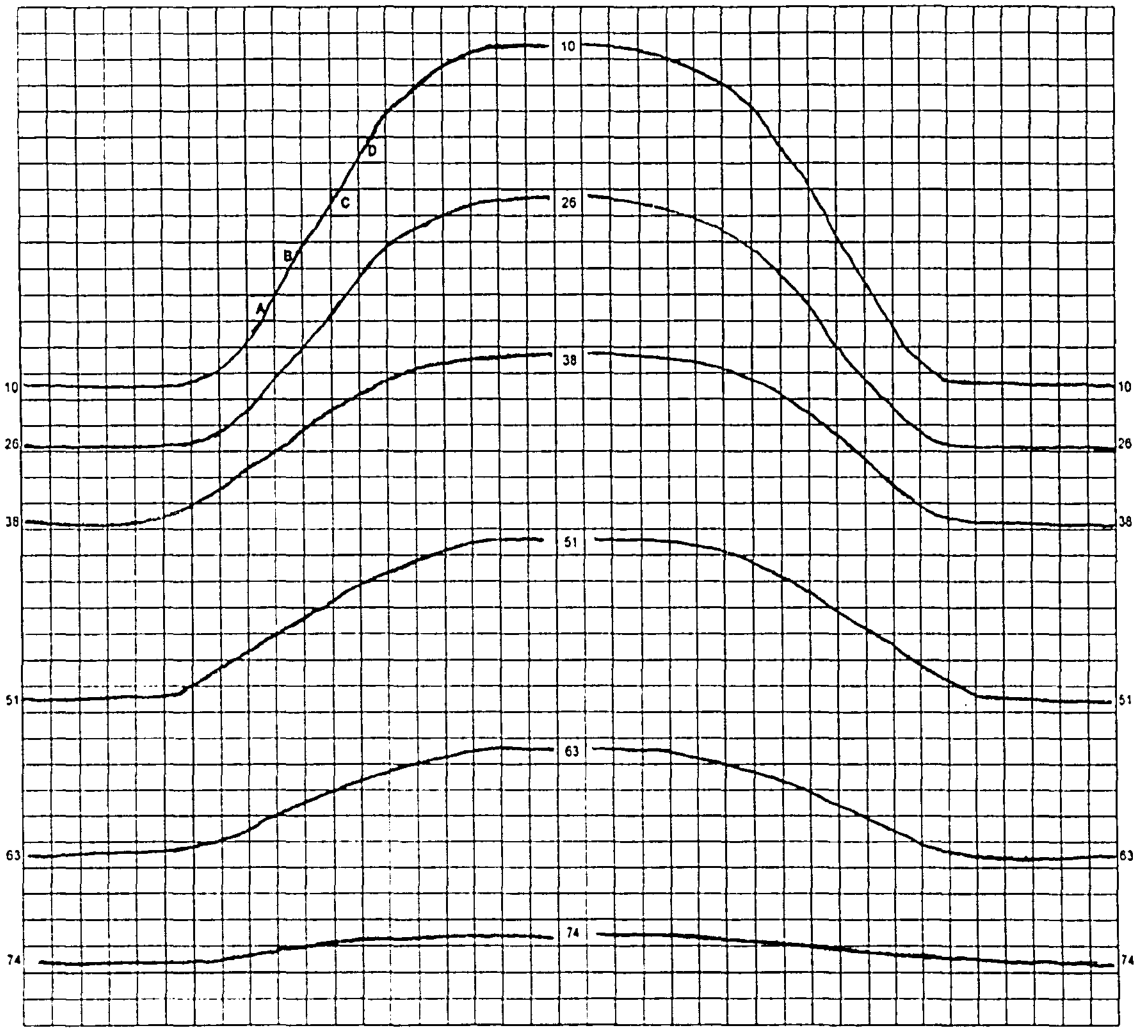

Figure 4.3. Experimental grid and site hydrography (water depths in m)

4.2 Offshore Wave Climate

As discussed in Section 3.4, the wave characteristics along the offshore boundary including deep water wave height, direction, and period, are required to run RCPWAVE. A deep water wave height of 1 m and a propagation direction of 0° are used for this investigation. Both 7 s and 10 s wave periods are tested, corresponding to wave frequencies of 0.1429 Hz and 0.1000 Hz respectively. These conditions are the monochromatic wave characteristics which represent the significant wave height, mean propagation direction and spectral peak frequencies for the one-dimensional and two-dimensional wave spectra cases. The next section discusses the individual deep water wave characteristics necessary for spectral wave propagation.

4.3 Spectral Component Analysis

A wave spectrum, composed of an infinite number of component wave heights and frequencies, can be simplified by identifying individual waves or frequency-angle components as depicted in Figure 4.4. These components are established through the use of frequency and angle bands with spacings Δf and Δθ respectively, where each represents a fraction of the total energy density of the spectrum. Each component is then propagated across the site hydrography using RCPWAVE, since each can be characterized by a representative wave height, frequency and direction. The individual results can then be combined to describe the transformed wave spectrum.

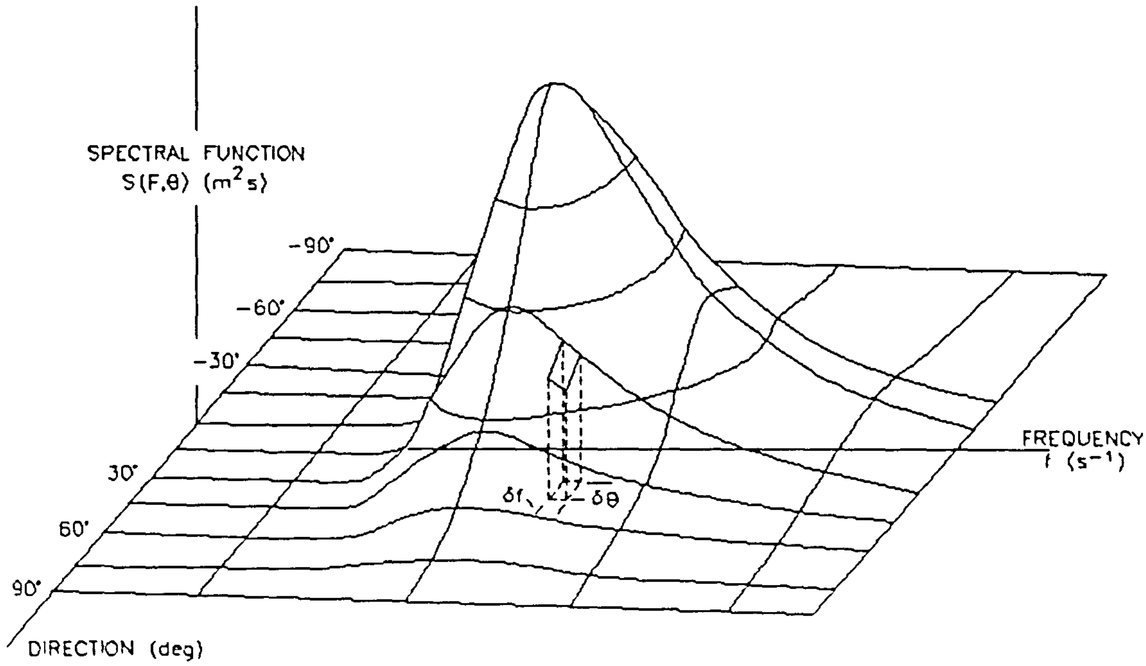

Figure 4.4. Definition of a frequency-angle component for a two-dimensional spectrum (USACE, 1984)

4.3.1 One-dimensional Spectral Components

One-dimensional wave spectra were generated by applying the JONSWAP spectral model, Equation 2.9, with upper and lower cutoff frequencies of 3 and 0.6 times the peak frequency. These frequency limits were chosen such that only approximately 1% of the total energy density is neglected. Values for Phillip's scaling parameter, α, for the 7 s and 10 s period waves were calculated as 0.001381 and 0.0003316 respectively using Equation 2.10 for a significant wave height of 1 m. The total energy of the wave spectrum is equal to the zeroth moment of the spectrum or the area under the spectral curve, i.e.:

$$m_o = \int_{0.6f_p}^{3f_p} S(f)df \tag{4.2}$$

where,

m_o zeroth moment of a wave spectrum

Since wave height is proportional to the square of energy density by definition, an approximate m_o can be calculated for a specific significant wave height by:

$$H_{mo} = 4\sqrt{m_o} \tag{4.3}$$

The total wave energy for a significant wave height of 1 m, using Equation 4.3, is 0.0618 m^2.

The one-dimensional spectra were divided into 10 frequency segments, where each band represented 10% of the total spectral energy, or 0.00618 m^2. The frequency limits for each segment were established using Maple © to solve a modified version of Equation 4.2 for a single component:

$$m_{oi} = \int_{f_i}^{f_i+\Delta f_i} S(f)df = 0.00618 \tag{4.4}$$

where,

m_{oi} zeroth moment of the ith frequency band

A sample Maple © file for the 7 s period wave showing these calculations is included in Appendix B. The generated frequency spectra and corresponding frequency bands for the 7 s and 10 s period waves are shown in Figures 4.5 and 4.6, respectively.

Each of these segments must be converted into an equivalent monochromatic wave, defined by a representative frequency, height, and direction, to be able to execute the simulations with RCPWAVE. The mean propagation direction for each frequency band remains as 0° since one-dimensional spectra are independent of direction. The spectral energy is converted to an equivalent wave height using the relationship from Equation 4.3:

$$H_{moi} = 4\sqrt{m_{oi}} \tag{4.5}$$

where,

H_{moi} deep water wave height for the ith frequency band

The representative deep water wave height for each frequency band, calculated from Equation 4.5, is 0.3144 m since the energy for each component is the same.

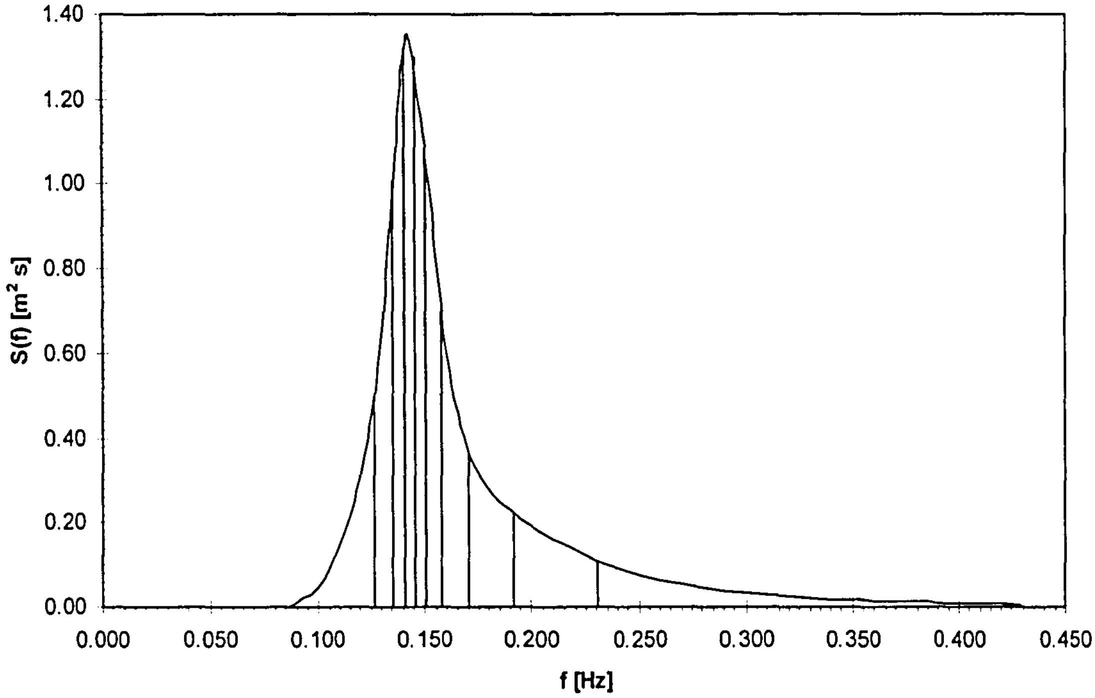

Figure 4.5. JONSWAP frequency spectra and frequency band division for $T_p = 7$ s

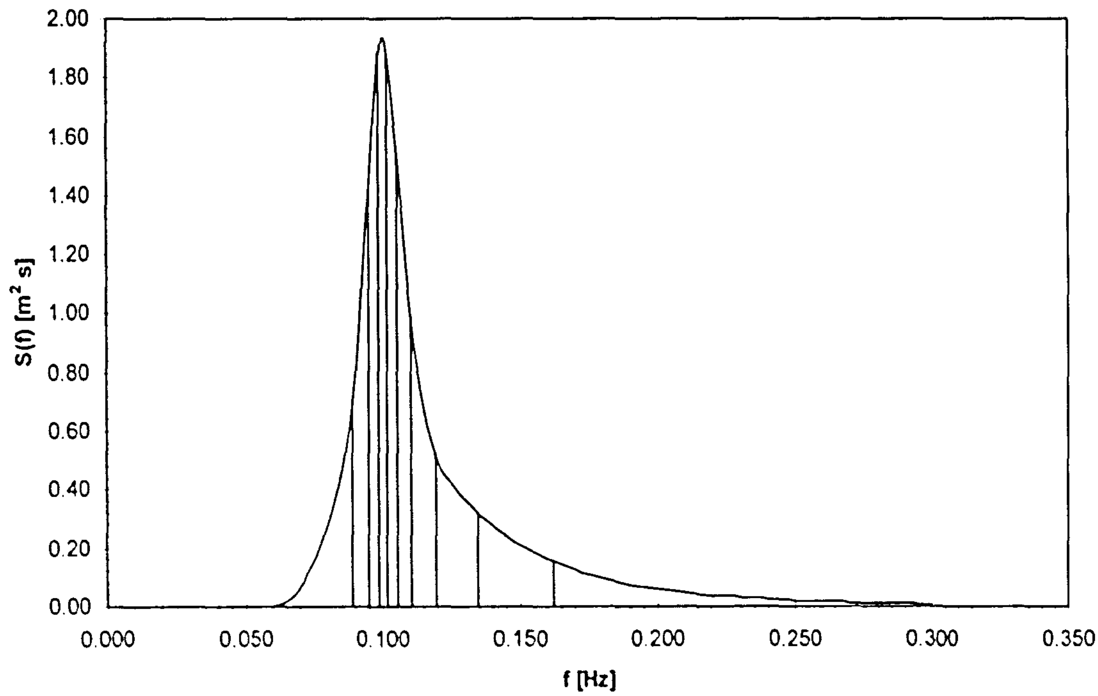

Figure 4.6. JONSWAP frequency spectra and frequency band division for $T_p = 10$ s

The representative frequency of each segment is characterized by the centroid of each band since this is where most of the energy is concentrated. The frequency and corresponding period for each component was calculated using Mathcad © to solve Equation 4.6 for the centroid of each frequency band.

$$f_i = \frac{\int_{f_i}^{f_i+\Delta f_i} f \cdot S(f)df}{\int_{f_i}^{f_i+\Delta f} S(f)df} \tag{4.6}$$

where,

f_i representative frequency for the ith frequency band

A sample Mathcad © file showing the calculations of the representative frequencies for the 7 s wave period is also included Appendix B. The deep water wave conditions for the one-dimensional frequency components used as input for RCPWAVE are shown in Tables C.1 and C.2 in Appendix C for the 7 s and 10 s period waves, respectively.

The resulting nearshore wave characteristics of a transformed wave spectrum are determined by combining the contributions from all the individual components. As discussed in Chapter 2, the variation in wave height for a single monochromatic wave is calculated by a combined shoaling and refraction coefficient using Equation 2.7. This transformation coefficient can also be related to wave energy density since wave energy is proportional to the square of the wave height by definition. Combining these two relationships yields the following expression for $K_s K_r$ with respect to wave energy density:

$$K_s K_r = \frac{H}{H_o} = \left[\frac{\overline{E}}{\overline{E}_o}\right]^{1/2} \tag{4.7}$$

Goda (2000) derived an equation for estimating an effective shoaling and refraction coefficient for a two-dimensional spectrum based on the relationship from Equation 4.7. The modified version of this equation for a one-dimensional spectrum is:

$$(K_s K_r)_{eff} = \left[\frac{1}{m_o} \int_0^\infty S(f) \cdot K_s^2(f) K_r^2(f,\theta) df \right]^{1/2} \tag{4.8}$$

where,

$(K_s K_r)_{eff}$ effective combined shoaling and refraction coefficient

$(K_s K_r)_{eff}$ can be approximated by (Goda, 2000):

$$(K_s K_r)_{eff} = \left[\sum_{i=1}^{M} (\Delta E)_i (K_s K_r)_i^2 \right]^{1/2} \tag{4.9}$$

where,

$(\Delta E)_i$ relative energy of the ith frequency component (m_{oi}/m_o)

The frequency components were determined so that each represented 10% of the total energy, yielding a $(\Delta E)_i$ of 0.10 for each frequency component. The $K_s K_r$ for an individual component is calculated from its nearshore wave height obtained from the RCPWAVE output, H_i, and its initial deep water wave height, H_{moi}:

$$(K_s K_r)_i = \frac{H_i}{H_{moi}} \tag{4.10}$$

The effective $K_s K_r$ calculated from Equation 4.9 represents the resulting nearshore variation in wave height for a one-dimensional spectrum since the significant deep water wave height is 1 m. Since the energy was equalized over the range of frequencies, the representative mean propagation direction is determined by taking the average of the resulting nearshore component directions.

4.3.2 Two-dimensional Spectral Components

Both the cosine-squared and Mitsuyasu spreading functions, discussed in Chapter 2, are applied to each of the JONSWAP frequency spectra shown in Figures 4.5 and 4.6 to generate two-dimensional wave spectra. Directional wave spectra must be divided into two-dimensional wave components using frequency and angle bands as illustrated in Figure 4.4. Similar to the one-dimensional spectrum, each component must be defined by a characteristic frequency, direction, and height.

The same frequency bands and corresponding representative frequencies from the one-dimensional spectral analysis are employed to determine the two-dimensional spectral components. Each of these frequency segments are divided into 18 angle bands with an equal spacing of 10°. The directional spread ranges from -90° to 90° and the representative propagation direction for each component is the angle at the center of the corresponding angle band. This means each directional spectrum is represented by 180 individual wave components as opposed to the 10 components characterizing the one-dimensional spectra.

The wave energy of a single frequency-angle component is expressed as:

$$m_{oij} = \int_{f_i}^{f_i+\Delta f_i} \int_{\theta_j}^{\theta_j+\Delta\theta_j} S(f,\theta)\,d\theta\,df \tag{4.11}$$

where,

m_{oij} zeroth moment of the ith frequency, jth angle component

Similar to Equation 4.5, the equivalent component wave height is then calculated using:

$$H_{moij} = 4\sqrt{m_{oij}} \tag{4.12}$$

where,

H_{moij} deep water wave height for the ith frequency, jth angle component

Mathcad © was used to solve Equations 4.11 and 4.12 for the two-dimensional spectral components. An example of the calculations for the two-dimensional wave spectral components using the Mitsuyasu spreading function for a wave period of 7 s is shown in Appendix D. The only difference in the calculations for the cosine-squared spreading function is the equation that defines the spreading function. The equation used to define this spreading function is also included in Appendix D. The resulting deep water wave conditions for the two-dimensional spectral components used as input for RCPWAVE are shown in Tables C.3 through C.6 in Appendix C.

The equation derived by Goda (2000) for the effective shoaling and refraction coefficient for a two-dimensional spectrum is:

$$(K_s K_r)_{eff} = \left[\frac{1}{m_o} \int_0^{\infty} \int_{\theta_{min}}^{\theta_{max}} S(f) \cdot K_s^2(f) K_r^2(f,\theta) d\theta df \right]^{1/2} \qquad (4.13)$$

Equation 4.13 is approximated by (Goda, 2000):

$$(K_s K_r)_{eff} = \left[\sum_{i=1}^{M} \sum_{j=1}^{N} (\Delta E)_{ij} \ (K_s K_r)_{ij}^2 \right]^{1/2} \qquad (4.13)$$

where,

$(\Delta E)_{ij}$ relative energy of the ith frequency, jth angle component

The effective $K_s K_r$ calculated from Equation 4.13 represents the resulting nearshore variation in wave height for a two-dimensional spectrum. $K_s K_r$ values for individual spectral components are calculated using the component deep water wave heights, H_{moij}, and nearshore wave heights,

H_{ij}, determined by RCPWAVE:

$$(K_s K_r)_{ij} = \frac{H_{ij}}{H_{moij}} \tag{4.14}$$

The representative mean spectral propagation direction is determined based on the centroid of the energy distribution with respect to frequency and direction, i.e:

$$\theta_{mean} = \frac{\int_0^{\infty}\int_{\theta_{\min}}^{\theta_{\max}} \theta \cdot S(f,\theta)\, d\theta df}{\int_0^{\infty}\int_{\theta_{\min}}^{\theta_{\max}} S(f,\theta)\, d\theta df} \tag{4.15}$$

which can be approximated using the resulting nearshore wave heights from RCPWAVE by:

$$\theta_{mean} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} \theta_{ij} \cdot \frac{H_{ij}^2}{8}}{\sum_{i=1}^{M}\sum_{j=1}^{N} \frac{H_{ij}^2}{8}} \tag{4.16}$$

5.0 RESULTS AND DISCUSSION

Each set of deep water wave conditions along with the offshore hydrography, discussed in Chapter 4, is input into RCPWAVE to simulate wave propagation over the experimental grid and to predict the resulting wave transformation characteristics for monochromatic, one-dimensional spectral, and two-dimensional spectral wave propagation. For each case, the output generated by RCPWAVE is evaluated at four different locations along the 10 m depth contour. The nearshore locations selected for analysis are listed below in Table 5.1 and are depicted on the experimental grid in Figure 4.3. The sites are located on the depth contour nearest to the shoreline and are spread out along the section of greatest curvature. By the time the waves reach these nearshore points of interest, they will have propagated over most of the experimental hydrography, transforming accordingly without breaking. Since the waves will undergo a significant degree of transformation, the nearshore wave results can be used to indicate the propagation effects for the eight different conditions, while avoiding effects due to wave breaking.

Table 5.1. Nearshore sites selected for analysis (water depth = 10 m)

	Grid Coordinates	
Site	[x]	[y]
A	12	9
B	10	10
C	8	12
D	6	13

The transformed wave characteristics at each location are reported in terms of a mean propagation direction and a combined shoaling and refraction coefficient, calculated from the nearshore wave height from RCPWAVE and a deep water wave height of 1 m. This chapter includes a discussion and comparison of the wave transformation results for the monochromatic, one-dimensional spectral and two-dimensional spectral wave propagation analyses.

5.1 Monochromatic Wave Propagation Analysis

The combined shoaling and refraction coefficients and mean propagation directions obtained from RCPWAVE for the 7 s and 10 s monochromatic wave conditions at each nearshore location are shown in Table 5.2. The combined shoaling and refraction coefficients represent the nearshore wave heights generated by RCPWAVE, since a deep water wave height of 1 m was used (Equation 2.7).

Table 5.2. Nearshore wave characteristics for monochromatic wave propagation

	$T_p = 7s$		$T_p = 10s$	
Site	(K_sK_r)	Θ_{mean} [°]	(K_sK_r)	Θ_{mean} [°]
A	0.8439	15.2512	0.8751	24.2792
B	0.7833	18.4944	0.8033	27.4386
C	0.7929	13.6893	0.8103	21.2086
D	0.7990	16.0897	0.8059	23.6215

The initial angle of approach is 0° with respect to the line orthogonal to the shore. The shift in propagation direction, shown in Table 5.2, indicates the effects of refraction as the waves propagate forward and orient themselves with the concave bottom contours. Consequently, longer period waves tend to interact with the sea floor in deeper water and endure greater refraction as they propagate toward shore. This is confirmed by a greater deviation from the initial propagation direction for the 10 s period wave as opposed to the 7 s period wave. Greater refraction for longer period waves will cause wave heights nearshore to be lower for the 10 s period wave as opposed to the 7 s wave period, if only refraction is considered. However, the nearshore K_sK_r results from Table 5.2 are slightly higher for the 10 s wave period. This indicates that the relative increase in wave height from shoaling effects were significant enough to counteract the decrease in wave height caused by refraction. To prove that this assertion is reasonable, the shoaling coefficient is calculated using Equation 2.5 as 0.9166 for 7 s and 0.9833 for 10 s. Apparently, this 7% difference in wave height variation was sufficient to overcome refraction and produce an average 2.5% increase in $K_s K_r$ for the 10s period relative to the 7 s period.

The results for both period waves show that the degree of wave transformation is greatest at Site B, i.e. lowest $K_s K_r$ and highest θ_{mean} values, and is least at Site A. This is reasonable since Site A is near the outside edge of the grid, where the depth contour begins to flatten out and eventually becomes perpendicular to the initial angle of approach. At Site B, the curvature of the depth contour increases, perhaps leading to a greater degree of wave divergence. Both period waves experience greater refraction at Site C as compared to Site D as indicated by the greater shift in wave direction. The variation in wave height, indicated by the shoaling and refraction coefficients, appears to be greater at Site C than Site D for the 7 s period wave, whereas the opposite is true for the 10 s period wave.

5.2 One-dimensional Spectral Wave Propagation Analysis

The one-dimensional wave spectra with peak wave periods of 7 s and 10 s are divided into 10 individual frequency components, each accounting for 10% of the total spectral energy. As outlined in Section 4.3.1, each component is defined by a representative frequency, a significant wave height of 0.3144 m, and an initial angle of approach of 0°. The frequency components with the deep water wave conditions shown in Tables D.1 and D.2 are each propagated over the experimental grid using RCPWAVE.

The wave conditions for the one-dimensional spectral components obtained from RCPWAVE at each nearshore location are summarized in Table E.1 for the 7 s wave period and Table E.3 for the 10 s wave period included in Appendix E. The range in magnitude of the resulting wave angles shows that each frequency component transforms differently, emphasizing the importance of considering a wave system as a compilation of different wave components with various wave heights and angles. For example, at Site A for the 7 s wave period, the deviation from the initial propagation direction ranges from a maximum of approximately 21° for the longest period wave component to nearly no change in direction for the shortest period wave component.

The component shoaling and refraction coefficients, calculated from the initial deep water wave height and nearshore wave heights using Equation 4.10, are summarized in Table E.2 for the 7 s wave period and Table E.4 for the 10 s wave period. The effective shoaling and refraction coefficient, estimated from Equation 4.9, and the mean propagation direction, calculated as the average of the component directions, for each wave spectrum at each nearshore location are tabulated below.

Table 5.3. Effective nearshore wave characteristics for one-dimensional wave propagation

	T_p = 7s		T_p = 10s	
Site	$(K_sK_r)_{eff}$	Θ_{mean} [°]	$(K_sK_r)_{eff}$	Θ_{mean} [°]
A	0.8744	12.0378	0.8765	20.8205
B	0.8252	14.7427	0.8105	23.8822
C	0.8318	10.8082	0.8169	18.2670
D	0.8348	12.8397	0.8143	20.5974

The general shift in propagation direction, shown in Table 5.3, suggests that the waves refract to adjust to the pattern of the bottom contours. The greater deviation in wave direction for the 10 s period as opposed to the 7s period wave confirms that longer period waves undergo greater refraction as they approach the shore.

Similar to the monochromatic wave results, the degree of wave transformation is greatest at Site B and is the least at Site A. This indicates that the waves diverge more where there is a greater curvature of the bottom contour. In contrast to the monochromatic waves, the overall trend in the shoaling and refraction coefficients suggests a slightly larger impact on the wave height for the 10 s period wave since the values are mostly less than those for the 7 s period wave. Trends comparable to the monochromatic wave case also occur with respect to Sites C and D. Larger wave angles occur for both wave periods at Site C as compared to Site D, suggesting a greater amount of refraction. Likewise, the shoaling and refraction coefficients reveal a slightly greater change in wave height at Site C than Site D for the 7 s period wave and the opposite is true for the 10 s period wave.

5.3 Two-dimensional Spectral Wave Propagation Analysis

Both the cosine-squared and Mitsuyasu spreading functions were employed to generate a directional spread of energy over the range of frequencies from the one-dimensional wave spectra. The energy in each frequency band was spread over a directional range of -85° to 85° and then divided into 18 angle bands with an equal spacing of 10°. This yields a total of 180 two-dimensional components to characterize each wave spectrum. The individual components are propagated over the site, where each is defined by a representative frequency, direction, and significant wave height as outlined in Section 4.3.2. Since the same frequency bands from the one-dimensional spectra are used, the same representative frequencies apply to the two-dimensional components. The representative wave directions are the angles at the center of each angle band. The significant wave height for each frequency-angle component is determined by converting the component energy into an equivalent wave height via Equation 4.12.

The deep water wave conditions for the two-dimensional wave components, used as input for RPCWAVE, for each spreading function and wave period are tabulated in Appendix C. The wave transformation characteristics obtained from RCPWAVE at each nearshore location for the two-dimensional spectral components using the cosine-squared and Mitsuyasu spreading functions are tabulated in Appendices F and G, respectively as well as the calculated shoaling and refraction coefficients for each component from Equation 4.12. Sample spreadsheets used for the combination of the two-dimensional spectral components are included in Appendix H.

Each frequency-angle component transforms to a different extent as shown by the range in nearshore wave heights and angles obtained from the propagation simulations. For example, at Site A for the 7 s wave period using the cosine-squared function, the component, nearshore propagation directions range from approximately -71° to 58°, which is a much wider spread as compared to considering only one-dimensional, frequency components. This signifies that the impact of the underlying hydrography on wave transformation is influenced by both wave period and approach direction and thus, the distribution of energy within a directional spectrum. These results reveal that wave transformation characteristics should be investigated for a representative range of frequencies and directions to realistically estimate the most critical wave height and direction combinations at a site of interest.

The results that are highlighted within the tables included in Appendices F and G reflect stability errors encountered during the transformation simulations. RCPWAVE suffers from computational instability for extremely oblique incident wave angles when no energy reaches a cell in the computational domain. In some instances where the program can not converge to a solution, the cells are either assigned a wave height of zero or one that is relatively large compared to the input wave height. The affected results for this investigation experienced the latter. The model's ability to resolve larger wave angles increases with the aspect ratio, dx / dy, of the computational grid, where dx and dy represent the length of grid cells in the x- and y-directions, respectively. An aspect ratio of 3 to 1 is recommended for maximum wave angles of +/- 86°, which was discovered through personal communication with Mark Gravens of the USACE CHL in Vicksburg, MA. Since the aspect ratio of the experimental grid is 1 to 1 and is less than the recommended ratio, the computational stability of the model may be restricted to angles that are less than the maximum of +/- 86°. The results, highlighted in Appendices F and G, correspond to input wave angles ranging from +/- 55° to +/-85°.

In a practical sense, a wave with a highly oblique angle of approach is essentially moving parallel to the shoreline and will contribute very little or essentially nothing to the nearshore wave condition. Therefore, the components corresponding to the highlighted results are assumed to have zero contribution to the transformed spectrum. The neglected components were determined based on a maximum acceptable shoaling and refraction coefficient. Since wave shoaling tends to increase wave height, depending on the depth to wavelength ratio, while refraction decreases wave height, the maximum combined coefficient would occur for the case of no refraction, i.e. when $K_r = 1$. So, the maximum possible combined coefficient that could occur would be equal to the shoaling coefficient given by Equation 2.5 for a monochromatic wave. The maximum acceptable $K_s K_r$ values calculated previously from Equation 2.5 for the 7 s and 10 s wave period are 0.9166 and 0.9833, respectively. The neglected wave components for the two-dimensional spectrum using the cosine-squared function represent between 1% and 3% of the total spectral energy depending on the nearshore location. The total neglected energy for the components using the Mitsuyasu function is less than 1% for each nearshore location.

The effective shoaling and refraction coefficient is estimated from Equation 4.13 and the mean propagation direction is calculated from Equation 4.16, representing the centroid of the energy distribution. The values obtained at each nearshore location using the cosine-squared and Mitsuyasu spreading functions are shown in Tables 5.4 and 5.5, respectively. Wave refraction is suggested by the general shift in propagation directions, shown in both Tables 5.4 and 5.5. Both spreading functions confirm greater refraction for longer period waves since the deviation in mean propagation direction is greater for the 10 s period wave as opposed to the 7 s period wave. The overall trend in the shoaling and refraction coefficients also suggests a slightly larger impact on the wave height for the 10 s period wave since the values are mostly less than those for the 7 s period wave.

Table 5.4. Effective nearshore wave characteristics for two-dimensional wave propagation using cosine-squared spreading function

	T_p = 7s		T_p = 10s	
Site	$(K_sK_r)_{eff}$	Θ_{mean} [°]	$(K_sK_r)_{eff}$	Θ_{mean} [°]
A	0.8746	13.5782	0.8665	21.9960
B	0.8330	17.8903	0.7996	27.3402
C	0.7946	16.9189	0.7631	23.5238
D	0.7804	19.2258	0.7498	25.9320

Table 5.5. Effective nearshore wave characteristics for two-dimensional wave propagation using Mitsuyasu spreading function

	T_p = 7s		T_p = 10s	
Site	$(K_sK_r)_{eff}$	Θ_{mean} [°]	$(K_sK_r)_{eff}$	Θ_{mean} [°]
A	0.8731	12.4919	0.8555	21.2857
B	0.8277	16.0271	0.7860	25.5404
C	0.8054	13.8481	0.7726	21.2916
D	0.8042	16.2470	0.7638	23.4040

Although both spreading functions reveal similar trends, there are slight differences between the combined results. There is a greater deviation in wave height and propagation at Sites A and B for the two-dimensional spectra using the Mitsuyasu function. The opposite is true for Sites C and D, where the transformation appears to be slightly greater for the two-dimensional spectra using the cosine-squared spreading function.

Similar to the monochromatic and one-dimensional spectral wave propagation results, the degree of wave transformation in terms of combined shoaling and refraction coefficients and wave direction is the least at Site A for both spreading functions. The variation in wave height appears to be the most significant at Site D rather than Site B as indicated by the lowest values of the shoaling and refraction coefficients for both period waves and spreading functions. However, the greatest shift in propagation direction occurs at Site D for the 7 s period wave and at Site B for the 10 s period wave for both spreading functions.

5.4 Comparison of Results

To quantify the effects of neglecting the variations in wave frequency and direction, which are characteristic of the natural sea surface, results obtained at each nearshore location for each wave propagation approach are examined. The discrepancies between the various wave propagation results are evaluated with respect to the estimates of shoaling and refraction coefficients and propagation directions. Specifically, the following comparisons are made based on a percent difference between the corresponding nearshore wave characteristics: one-dimensional versus monochromatic wave propagation, two-dimensional versus monochromatic wave propagation, and two-dimensional versus one-dimensional wave propagation. The propagation method listed first in each combination is considered to be a more realistic representation of the natural sea surface compared to the method listed second. Therefore, the percent difference between the combined transformation coefficients and wave directions are calculated with respect to the more accurate estimate of the wave transformation characteristics. A detailed discussion of the comparisons made between the results from different propagation analyses is provided below.

5.4.1 One-dimensional versus Monochromatic Wave Propagation

The percent difference between the combined shoaling and refraction coefficients obtained from the one-dimensional versus monochromatic wave propagation analyses are shown in Table 5.6 below.

Table 5.6. Comparison of effective nearshore combined shoaling/refraction coefficients for one-dimensional versus monochromatic wave propagation

	$T_p = 7s$			$T_p = 10s$		
Site	1-D $(K_sK_r)_{eff}$	Monochromatic (K_sK_r)	% Difference	1-D $(K_sK_r)_{eff}$	Monochromatic (K_sK_r)	% Difference
A	0.8744	0.8439	3.49	0.8765	0.8751	0.16
B	0.8252	0.7833	5.08	0.8105	0.8033	0.89
C	0.8318	0.7929	4.68	0.8169	0.8103	0.81
D	0.8348	0.7990	4.29	0.8143	0.8059	1.03

From Table 5.6, the K_sK_r values are greater for the one-dimensional wave spectra, suggesting that overall the monochromatic analysis slightly underestimated the nearshore wave heights and more so for shorter period waves. For the 7 s period wave, the percent increase in K_sK_r with respect to the one-dimensional analysis ranges from approximately 3.5% at Site A to 5% at Site B. The percent increase for the 10 s period wave is much less, ranging from less than 1% at Site A to 1% at Site D.

The percent difference between the nearshore propagation directions obtained from the one-dimensional versus monochromatic wave propagation analyses are summarized in Table 5.7.

Table 5.7. Comparison of nearshore mean propagation directions for one-dimensional versus monochromatic wave propagation

	$T_p = 7s$			$T_p = 10s$		
Site	1-D θ_{mean} [°]	Monochromatic θ_{mean} [°]	% Difference	1-D θ_{mean} [°]	Monochromatic θ_{mean} [°]	% Difference
A	12.0378	15.2512	-26.69	20.8205	24.2792	-16.61
B	14.7427	18.4944	-25.45	23.8822	27.4386	-14.89
C	10.8082	13.6893	-26.66	18.2670	21.2086	-16.10
D	12.8397	16.0897	-25.31	20.5974	23.6215	-14.68

The overall difference in nearshore propagation direction between the one-dimensional and monochromatic results is much greater than that observed for the nearshore K_sK_r values. Note that a negative value for the percent difference indicates a percent decrease between the one-dimensional as compared to the monochromatic results. In general, it appears that there is greater refraction for the monochromatic waves where the percent decrease in propagation direction ranges from approximately 25% at Site D to 27% at Site A for a period of 7 s. Similar to the $K_s K_r$ comparisons, the percent decrease is less significant for a period of 10 s, ranging from 15% at Site D to 17% at Site A.

5.4.2 Two-dimensional versus Monochromatic Wave Propagation

Table 5.8. shows the percent difference between the combined shoaling and refraction coefficients obtained from the two-dimensional spectra using the cosine-squared function versus monochromatic wave propagation analyses.

Table 5.8. Comparison of effective nearshore combined shoaling/refraction coefficients for two-dimensional (cosine-squared function) versus monochromatic wave propagation

	T_p = 7s			T_p = 10s		
Site	Cosine-squared $(K_sK_r)_{eff}$	Monochromatic (K_sK_r)	% Difference	Cosine-squared $(K_sK_r)_{eff}$	Monochromatic (K_sK_r)	% Difference
A	0.8746	0.8439	3.51	0.8665	0.8751	-0.99
B	0.8330	0.7833	5.97	0.7996	0.8033	-0.46
C	0.7946	0.7929	0.21	0.7631	0.8103	-6.19
D	0.7804	0.7990	-2.38	0.7498	0.8059	-7.48

For the wave period of 7 s, most of the nearshore $K_s K_r$ values are greater for the cosine-squared spectrum with the exception of Site D where the percent decrease is approximately 2%. The overall percent increase ranges from 3.5% at Site A to less than 1% at Site C. Conversely, for the 10 s period waves, the $K_s K_r$ values are consistently lower for the cosine-squared spectrum with a percent decrease between 1% at Site A and 7.5% at Site D. These results suggest that a monochromatic analysis tends to overestimate nearshore wave heights for longer period waves and underestimates these values for shorter wave periods.

The comparisons made between the combined shoaling and refraction coefficients obtained from the two-dimensional spectra using the Mitsuyasu function versus monochromatic wave propagation analyses are summarized in Table 5.9. Similar to the results for cosine-squared function, the wave heights appear to be overestimated by a monochromatic approach for longer wave periods and underestimated for shorter wave periods. For the 7 s period waves, the $K_s K_r$ values are all greater for the Mitsuyasu function, with a range in percent increase between less than 1% at Site D and 5% at Site B. The percent decrease with respect to the Mitsuyasu function for the period of 10 s varies from 2% at Site B to 5.5% at Site D.

Table 5.9. Comparison of effective nearshore combined shoaling/refraction coefficients for two-dimensional (Mitsuyasu function) versus monochromatic wave propagation

	T_p = 7s			T_p = 10s		
Site	Mitsuyasu $(K_sK_r)_{eff}$	Monochromatic (K_sK_r)	% Difference	Mitsuyasu $(K_sK_r)_{eff}$	Monochromatic (K_sK_r)	% Difference
A	0.8731	0.8439	3.34	0.8555	0.8751	-2.29
B	0.8277	0.7833	5.36	0.7860	0.8033	-2.20
C	0.8054	0.7929	1.55	0.7726	0.8103	-4.88
D	0.8042	0.7990	0.65	0.7638	0.8059	-5.51

The percent difference between the nearshore propagation directions obtained from the two-dimensional spectra using the cosine-squared function versus monochromatic wave propagation analyses are summarized in Table 5.10. There is no clear trend in the results for the difference in nearshore propagation directions. However, for both period waves the monochromatic approach appears to overestimate the effects of refraction at Sites A and B, where there is a percent decrease, and underestimates refraction for Sites C and D since there is a significant percent increase.

Table 5.10. Comparison of nearshore mean propagation directions for two-dimensional (cosine-squared function) versus monochromatic wave propagation

	$T_p = 7s$			$T_p = 10s$		
Site	Cosine-squared Θ_{mean} [°]	Monochromatic Θ_{mean} [°]	% Difference	Cosine-squared Θ_{mean} [°]	Monochromatic Θ_{mean} [°]	% Difference
A	13.5782	15.2512	-12.32	21.9960	24.2792	-10.38
B	17.8903	18.4944	-3.38	27.3402	27.4386	-0.36
C	16.9189	13.6893	19.09	23.5238	21.2086	9.84
D	19.2258	16.0897	16.31	25.9320	23.6215	8.91

The percent difference between the nearshore propagation directions obtained from the two-dimensional spectra using the Mitsuyasu function versus monochromatic wave propagation analyses are shown in Table 5.11. Similar to the cosine-squared function results for the 7 s wave period, the nearshore propagation directions for the Mitsuyasu function are less than those for the monochromatic case at Sites A and B, but slightly greater for Sites C and D. Overall, it seems that the monochromatic wave approach slightly overestimates refraction for shorter period waves. For the 10 s period waves, the wave angles are also mostly less for the Mitsuyasu function than the monochromatic results, suggesting an overestimate of refraction effects by the monochromatic approach for longer period waves as well.

Table 5.11. Comparison of nearshore mean propagation directions for two-dimensional (Mitsuyasu function) versus monochromatic wave propagation

	$T_p = 7s$			$T_p = 10s$		
Site	Mitsuyasu Θ_{mean} [°]	Monochromatic Θ_{mean} [°]	% Difference	Mitsuyasu Θ_{mean} [°]	Monochromatic Θ_{mean} [°]	% Difference
A	12.4919	15.2512	-22.09	21.2857	24.2792	-14.06
B	16.0271	18.4944	-15.39	25.5404	27.4386	-7.43
C	13.8481	13.6893	1.15	21.2916	21.2086	0.39
D	16.2470	16.0897	0.97	23.4040	23.6215	-0.93

5.4.3 Two-dimensional versus One-dimensional Wave Propagation

Two-dimensional wave spectra more realistically represent natural waves than one-dimensional spectra, since frequency as well as direction is incorporated into the distribution of spectral energy. The relative increases and decreases with respect to combined shoaling and refraction coefficients for the two-dimensional versus one-dimensional wave propagation comparisons are shown in Tables 5.12 and 5.13 for the cosine-squared function and Mitsuyasu function, respectively.

In Table 5.12, the percent difference between the cosine-squared function and the one-dimensional transformation coefficients ranges from an increase of 1% at Site A to a decrease of 7% at Site D for the 7 s period waves and from a decrease of 1% at Site A to 9% at Site D for the 10 s period waves.

Table 5.12. Comparison of effective nearshore combined shoaling/refraction coefficients for two-dimensional (cosine-squared function) versus one-dimensional wave propagation

	T_p = 7s			T_p = 10s		
Site	Cosine-squared $(K_sK_r)_{eff}$	1-D $(K_sK_r)_{eff}$	% Difference	Cosine-squared $(K_sK_r)_{eff}$	1-D $(K_sK_r)_{eff}$	% Difference
A	0.8746	0.8744	0.02	0.8665	0.8765	-1.15
B	0.8330	0.8252	0.94	0.7996	0.8105	-1.36
C	0.7946	0.8318	-4.68	0.7631	0.8169	-7.05
D	0.7804	0.8348	-6.97	0.7498	0.8143	-8.60

The difference between the transformation coefficients for the Mitsuyasu function and the one-dimensional results, shown in Table 5.13, ranges from an increase of less than 1% at Site B to a decrease of 4% at Site D for the 7 s wave period and from a decrease of 2.5% at Site A to 7% at Site D for the 10 s wave period. The results for both spreading functions as compared to the one-dimensional case reveal that in general, nearshore wave heights are slightly overestimated by a one-dimensional analysis and more so for longer period waves.

Table 5.13. Comparison of effective nearshore combined shoaling/refraction coefficients for two-dimensional (Mitsuyasu function) versus one-dimensional wave propagation

	T_p = 7s			T_p = 10s		
	Mitsuyasu	1-D	%	Mitsuyasu	1-D	%
Site	$(K_sK_r)_{eff}$	$(K_sK_r)_{eff}$	Difference	$(K_sK_r)_{eff}$	$(K_sK_r)_{eff}$	Difference
A	0.8731	0.8744	-0.15	0.8555	0.8765	-2.45
B	0.8277	0.8252	0.30	0.7860	0.8105	-3.12
C	0.8054	0.8318	-3.28	0.7726	0.8169	-5.73
D	0.8042	0.8348	-3.81	0.7638	0.8143	-6.61

The comparisons of a two-dimensional and one-dimensional propagation analysis in terms of nearshore propagation directions are summarized below in Tables 5.14 and 5.15 for the cosine-quared and Mitsuyasu functions, respectively.

Table 5.14. Comparison of nearshore mean propagation directions for two-dimensional (cosine-squared function) versus one-dimensional wave propagation

	T_p = 7s			T_p = 10s		
	Cosine-squared	1-D	%	Cosine-squared	1-D	%
Site	θ_{mean} [°]	θ_{mean} [°]	Difference	θ_{mean} [°]	θ_{mean} [°]	Difference
A	13.5782	12.0378	11.34	21.9960	20.8205	5.34
B	17.8903	14.7427	17.59	27.3402	23.8822	12.65
C	16.9189	10.8082	36.12	23.5238	18.2670	22.35
D	19.2258	12.8397	33.22	25.9320	20.5974	20.57

Table 5.14 shows that the nearshore propagation directions for the cosine-squared function are all greater than the one-dimensional results, where there is a significant percent difference ranging from 11% to 36% for the 7 s wave period and from 5% to 22% for the 10 s wave period. The maximum and minimum differences occur at Sites C and A, respectively for both wave periods. Overall, these results signify that the one-dimensional analysis significantly underestimates refraction effects as compared to a two-dimensional analysis using the cosine-squared function.

Table 5.15. Comparison of nearshore mean propagation directions for two-dimensional (Mitsuyasu function) versus one-dimensional wave propagation

	T_p = 7s			T_p = 10s		
	Mitsuyasu	1-D	%	Mitsuyasu	1-D	%
Site	Θ_{mean} [°]	Θ_{mean} [°]	Difference	Θ_{mean} [°]	Θ_{mean} [°]	Difference
A	12.4919	12.0378	3.64	21.2857	20.8205	2.19
B	16.0271	14.7427	8.01	25.5404	23.8822	6.49
C	13.8481	10.8082	21.95	21.2916	18.2670	14.21
D	16.2470	12.8397	20.97	23.4040	20.5974	11.99

Similar to the results above, Table 5.15 shows that the nearshore propagation directions are greater for the Mitsuyasu function as compared to the one-dimensional analysis. The percent difference is not as great as above, where the percent difference ranges from 4% to 22% for the 7 s wave period and from 2% to 12% for the 10 s wave period. However, the maximum and minimum differences occur again at Sites C and A, respectively for both wave periods. These results confirm that a one-dimensional analysis may significantly underestimate refraction effects with respect to propagation direction and more so for shorter wave periods.

5.5 Engineering Significance

The management of the coastal zone involves various shore protection and stabilization projects. Knowledge of the environmental conditions to which these projects will be subjected is required to ensure their functionality. Waves, in particular, significantly impact coastal zone processes and the performance of coastal structures. Coastal engineers must be able to anticipate how waves transform during their propagation toward the shore to predict wave conditions that occur at a site of interest and are representative of the true environment.

Several different methods are available and used to analyze the transformation of sea waves. Each has advantages and disadvantages. In this study, monochromatic, one-dimensional, and two-dimensional approaches were investigated and compared to determine the validity of simplified analyses. The two-dimensional spectrum is considered to be the most accurate representation of a natural sea state. The purpose of this section is to discuss the effects of using generalized wave propagation analyses as they relate to two examples of coastal design applications: coastal structures, and coastal sediment transport.

5.5.1 Coastal Structures

Coastal structures are implemented for various coastal protection efforts including, but not limited to, the stabilization of beaches and the development of safe and efficient navigation channels. Rigid structures such as breakwaters and seawalls are designed in terms of wave pressures and forces. The expected wave loading on a structure depends heavily on the critical wave height occurring at the structure's location obtained from a propagation analysis. For example, the armor stone size required for a structure is a function of the wave height cubed. The results discussed in Section 5.4 suggest that wave heights are slightly overestimated for longer period waves and underestimated for shorter period waves using the monochromatic approach. From the one-dimensional results, the wave heights appear to be slightly overestimated in general but more so for longer wave periods. Although the combined shoaling and refraction coefficients for both the monochromatic and one-dimensional analyses are similar to the two-dimensional results, overestimating design wave heights can be costly depending on the size of the project since larger wave heights may require larger structures. The risk associated with underestimating a wave height is even greater since a structure will most likely fail or experience wave overtopping under the attack of waves higher than that predicted.

5.5.2 Coastal Sediment Transport

Direct wave action and wave-induced littoral currents strongly impact the stability of a shoreline. To predict shoreline changes, coastal engineers must estimate rates of sediment transport. For example, the formula developed by the U.S. Army Coastal Engineering Research Center (CERC) to estimate volumetric longshore sediment transport is a function of the breaking wave height and the angle of wave approach with respect to the shoreline (Sorensen, 1997). In general, more oblique angles of approach lead to higher sediment transport loads. Overall, both the monochromatic and one-dimensional analyses significantly overestimated refraction effects yielding much greater wave angles than the two-dimensional results, as discussed in Section 5.4. This could lead to an overestimate of sediment transport rates and prediction of exaggerated coastal erosion in certain areas. These overly conservative estimates may result in designs that are economically inefficient.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

Estimates of critical wave conditions at a desired nearshore location are obtained from various wave transformation calculations which typically include the effects of wave shoaling, refraction, and diffraction. The resulting transformation characteristics are then used for coastal design projects to anticipate the magnitude of random sea waves affecting nearshore areas. There are several approaches available and employed in practice to analyze the transformations that occur as waves propagate toward shore. First-order analyses are commonly used where the natural sea surface, composed of many random waves of various heights, periods, and directions, is represented by a single wave height, direction, and period. Although inexpensive and simple to apply, this monochromatic approach bears the risk of large estimation error since separate components shoal, refract, and diffract differently. A more realistic representation of the sea surface is a two-dimensional wave spectrum, which describes the distribution of wave energy over a range of frequencies and directions. One-dimensional wave spectra are also used for propagation analyses, where directionality is eliminated and wave energy is a function of frequency only.

The main objective of this study was to investigate the effects of neglecting variations in wave frequency and direction when determining wave transformation characteristics. This was accomplished by comparing nearshore wave heights, i.e. combined shoaling and refraction coefficients, and propagation directions obtained from monochromatic, one-dimensional spectral, and two-dimensional spectral wave propagation analyses. Deep water waves with a significant wave height of 1 m and wave periods of 7 s and 10 s were propagated over concave hydrography to nearshore depth of 10 m using RCPWAVE to simulate the effects of shoaling, refraction, and diffraction.

Although slight differences occurred with respect to nearshore wave heights, the results suggest that one-dimensional analyses yield conservative estimates, while monochromatic analyses produce conservative values for longer period waves and underestimate values for shorter period waves. Discrepancies were more significant for the estimates of nearshore propagation directions. In general, both the monochromatic and one-dimensional analyses significantly overestimated nearshore wave angles with respect to the two-dimensional results.

The primary conclusion from these results is that monochromatic and one-dimensional analyses are acceptable estimates for preliminary indices of the magnitude of random sea waves occurring at a particular site of interest. However, it is important to realize that the process of wave transformation is sensitive to the distribution of energy within a directional spectrum as shown by the extensive range of nearshore wave heights and directions obtained for the two-dimensional spectral conditions. Therefore, comprehensive investigations may be required to determine wave transformation characteristics for a representative range of frequencies and directions to realistically estimate the most critical wave conditions for coastal design depending on the application. For example, the design of coastal structures depends heavily on wave heights occurring at the structure, whereas estimating sediment transport rates is influenced by both wave height and angle of approach. Risks associated with estimation error include loss of life, property damage, and high costs, and vary depending on the scope of the project. In general, the analysis method employed to predict nearshore wave conditions should balance the risks of estimation error and economic efficiency. The resulting wave characteristics used for coastal design should accurately represent the true environmental conditions to guarantee a project's designated performance.

6.2 Recommendations for Future Research

From this study, it is evident that neglecting variations in wave directions and frequencies when analyzing the transformation of waves produces nearshore wave characteristics that may contain large estimation errors. To further quantify the effects of using simplified propagation analyses for coastal design, additional studies are recommended:

- Spectral wave data: The deep water wave conditions used to represent one-dimensional and two-dimensional spectra are based on empirical models and spectral component analyses. Additional propagation analyses should be conducted using actual one-dimensional and directional spectral data from field measurements. This would be most useful if it employed concurrent measurements from deep water and nearshore.

- Numerical modeling software: The RCPWAVE program used to simulate wave propagation for this study is strictly for linear, monochromatic waves. Therefore, the wave spectra had to be manually separated into components and modeled individually, yielding very approximate results for the transformed spectral waves. STWAVE (Steady-state spectral WAVE Model) is a steady-state, finite difference based, numerical model also developed by USACE that simulates spectral wave energy propagation. Input requirements, including deep water wave characteristics and site hydrography, are similar to RCPWAVE. However, this program performs the component analysis and propagations and recombines the results automatically. For convenience and possibly more accurate results, STWAVE should be used for the simulation of spectral waves.

- Design Applications: To quantify the discrepancies associated with using more simplified propagation analyses, transformation characteristics obtained from different analysis methods can be applied to specific design applications. For example, further studies can be conducted for specific sites and projects using different wave characteristics and applying the appropriate equations for different types of structures or coastal sediment transport.

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APPENDIX A:

Sample RCPWAVE input and output files used in this analysis

Sample input data set for RCPWAVE

```
FILES    RCP_OUT
GENSPECS                SMS WORKBOOK TEST                                  METRIC
GRIDSPEC RECTANG  METRIC      39       39    400.0    400.0
WAVCOND      1.0      7.0      0.0      0.0      YES
SAVESPEC       TEST1.NSR
 15 15 15 15 15 15 14 13 12 10
  9  8  6  5  4  3  3  2  2  2
  2  2  3  3  4  5  6  8  9 10
 12 13 14 15 15 15 15 15 15
PRWINDOW       1       14       1       20   DAHKB
BATHSPEC  METERS      0.0      0.0              YX         (10F7.1)
   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -2.0   -2.0
   -3.0   -3.0   -4.0   -5.0   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0
   -6.0   -6.0   -6.0   -6.0   -6.0   -5.0   -4.0   -3.0   -3.0   -2.0
   -2.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0
   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -2.0   -2.0   -3.0
   -3.0   -4.0   -5.0   -6.0   -7.0   -8.0   -8.0  -10.0  -10.0  -10.0
  -10.0  -10.0   -8.0   -8.0   -7.0   -6.0   -5.0   -4.0   -3.0   -3.0
   -2.0   -2.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0
   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -3.0   -3.0
   -4.0   -5.0   -6.0   -7.0   -9.0  -10.0  -10.0  -12.0  -12.0  -12.0
  -12.0  -12.0  -10.0  -10.0   -9.0   -7.0   -6.0   -5.0   -4.0   -3.0
   -3.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0
   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -3.0   -3.0   -4.0
   -5.0   -6.0   -7.0   -9.0  -10.0  -13.0  -13.0  -14.0  -14.0  -15.0
  -14.0  -14.0  -13.0  -13.0  -10.0   -9.0   -7.0   -6.0   -5.0   -4.0
   -3.0   -3.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0   -2.0
   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -4.0   -5.0
   -6.0   -7.0   -9.0  -11.0  -13.0  -15.0  -16.0  -17.0  -17.0  -18.0
  -17.0  -17.0  -16.0  -15.0  -13.0  -11.0   -9.0   -7.0   -6.0   -5.0
   -4.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0
   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -4.0   -5.0   -6.0
   -7.0   -8.0  -10.0  -14.0  -16.0  -18.0  -19.0  -20.0  -20.0  -21.0
  -20.0  -20.0  -19.0  -18.0  -16.0  -14.0  -10.0   -8.0   -7.0   -6.0
   -5.0   -4.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0   -3.0
   -4.0   -4.0   -4.0   -4.0   -4.0   -4.0   -4.0   -5.0   -6.0   -6.0
   -8.0  -10.0  -10.0  -17.0  -19.0  -21.0  -22.0  -22.0  -23.0  -23.0
  -23.0  -22.0  -22.0  -21.0  -19.0  -17.0  -10.0  -10.0   -8.0   -6.0
   -6.0   -5.0   -4.0   -4.0   -4.0   -4.0   -4.0   -4.0   -4.0
   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -6.0   -7.0
   -9.0  -10.0  -17.0  -20.0  -22.0  -24.0  -25.0  -26.0  -26.0  -26.0
  -26.0  -26.0  -25.0  -24.0  -22.0  -20.0  -17.0  -10.0   -9.0   -7.0
   -6.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0
   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -6.0   -7.0   -9.0
  -10.0  -16.0  -20.0  -23.0  -26.0  -26.0  -27.0  -28.0  -28.0  -28.0
  -28.0  -28.0  -27.0  -26.0  -26.0  -23.0  -20.0  -16.0  -10.0   -9.0
   -7.0   -6.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0   -5.0
   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0   -7.0   -8.0  -10.0
  -15.0  -20.0  -24.0  -26.0  -28.0  -29.0  -29.0  -30.0  -30.0  -30.0
  -30.0  -30.0  -29.0  -29.0  -28.0  -26.0  -24.0  -20.0  -15.0  -10.0
   -8.0   -7.0   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0
   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0   -7.0   -8.0   -9.0  -12.0
  -18.0  -23.0  -26.0  -29.0  -30.0  -31.0  -31.0  -32.0  -32.0  -32.0
  -32.0  -32.0  -31.0  -31.0  -30.0  -29.0  -26.0  -23.0  -18.0  -12.0
   -9.0   -8.0   -7.0   -6.0   -6.0   -6.0   -6.0   -6.0   -6.0
   -7.0   -7.0   -7.0   -7.0   -7.0   -7.0   -8.0   -9.0  -10.0  -16.0
  -22.0  -26.0  -29.0  -31.0  -32.0  -33.0  -34.0  -34.0  -34.0  -34.0
  -34.0  -34.0  -34.0  -33.0  -32.0  -31.0  -29.0  -26.0  -22.0  -16.0
```

-10.0	-9.0	-8.0	-7.0	-7.0	-7.0	-7.0	-7.0	-7.0	
-8.0	-8.0	-8.0	-8.0	-8.0	-8.0	-9.0	-10.0	-14.0	-20.0
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-36.0	-36.0	-35.0	-35.0	-34.0	-33.0	-31.0	-29.0	-26.0	-20.0
-14.0	-10.0	-9.0	-8.0	-8.0	-8.0	-8.0	-8.0	-8.0	
-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-10.0	-10.0	-18.0	-26.0
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-38.0	-38.0	-38.0	-37.0	-36.0	-35.0	-34.0	-32.0	-29.0	-26.0
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-28.0	-26.0	-18.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	
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-46.0	-47.0	-48.0	-51.0	-51.0	-52.0	-52.0	-52.0	-52.0	-52.0
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-70.0	-70.0	-70.0	-70.0	-71.0	-72.0	-72.0	-72.0	-72.0	-73.0
-73.0	-73.0	-73.0	-73.0	-73.0	-74.0	-74.0	-74.0	-74.0	-74.0
-74.0	-74.0	-74.0	-74.0	-73.0	-73.0	-73.0	-73.0	-73.0	-73.0
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-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-75.0	-75.0
-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0
-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0
-75.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	
-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0
-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0
-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0
-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	-76.0	
-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0
-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0
-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0
-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	-78.0	

Standard RCPWAVE output file

```
SHORELINE MODELING SYSTEM (SMS): PC RCPWAVE, VERSION 1.

 ----               SMS WORKBOOK TEST                                      ----

 ***** FILES CARD:  SPECIFICATION OF PERMANENT FILE NAMES FOR DATA STORAGE
                    AND RETRIEVAL


 VARIABLE  DESCRIPTION OF USAGE:                       VALUE:
 --------  ----------------------------------         --------
 FNPRNT    FILE FOR PRINTED OUTPUT                    RCP_OUT
 FOUT      SAVESPEC FILE FOR OUTPUT                     TEST1

 ***** GENSPECS CARD:  SPECIFICATION OF TITLE AND GENERAL SYSTEM OF UNITS

 VARIABLE  DESCRIPTION OF USAGE:                 VALUE:    NOTES:
 --------  ----------------------------------  --------  ------
 SUNITS    UNITS SYSTEM USED IN COMPUTATIONS    METRIC

 ***** GRIDSPEC CARD:  SPECIFICATION OF THE TYPE OF FINITE-DIFFERENCE GRID USED

 VARIABLE  DESCRIPTION OF USAGE:                 VALUE:    NOTES:
 --------  ----------------------------------  --------  ------
 GRTYPE    TYPE OF FINITE-DIFFERENCE GRID       RECTANG
 GUNITS    SYSTEM OF UNITS USED FOR THE GRID    METRIC
 XCELL     NUMBER OF GRID CELLS, X DIRECTION          39
 YCELL     NUMBER OF GRID CELLS, Y DIRECTION          39
 DX        SPATIAL STEPSIZE IN X DIRECTION        400.00
 DY        SPATIAL STEPSIZE IN Y DIRECTION        400.00

 ***** PRINTING OF FIELD ARRAY VARIABLES:   1 AREAS

  AREA  *  STARTING  ENDING   STARTING  ENDING          *  VARIABLE FIELD
 NUMBER *   X CELL   X CELL    Y CELL   Y CELL  NOTES: * ARRAYS TO PRINT:
NOTES:
 ------ *  --------  ------   --------  ------  ------ * ---------------- -----
    1   *  X=   1    X=  14   Y=   1    Y=  20          * DAHKB

 ***** WAVCOND CARD:  NUMBER OF WAVE CONDITIONS:   1

      WAVE CONDITION NUMBER:   1

 VARIABLE  DESCRIPTION OF USAGE:                 VALUE:    NOTES:
 --------  ----------------------------------  --------  ------
 TDEEP     WAVE PERIOD                              7.00
 HDEEP     DEEPWATER WAVE HEIGHT                    1.00
 ZDEEP     DEEPWATER WAVE ANGLE                     0.00
 CNTRANG   OFFSHORE CONTOUR ANGLE                   0.00
 DIFFR     DIFFRACTION SIMULATED                YES

 ***** SAVESPEC CARD:
          15          15          15          15          15          15
          14          13          12          10           9           8
           6           5           4           3           3           2
           2           2           2           2           3           3
           4           5           6           8           9          10
          12          13          14          15          15          15
          15          15          15
```

SHORELINE MODELING SYSTEM (SMS): PC RCPWAVE, VERSION 1.
***** PROTOTYPE DISTANCES IN THE COMPUTATIONAL GRID IN METERS *****
X-DIRECTION: 39 CELLS
DX = 400.00 METERS

CELL INDEX		FACE TO FACE DISTANCES	CENTER-CENTER DISTANCES	DISTANCES FROM ORIGIN
-----	FACE			0.0
1	CENTER	400.000		200.0
-----	FACE		400.000	400.0
2	CENTER	400.000		600.0
-----	FACE		400.000	800.0
3	CENTER	400.000		1000.0
-----	FACE		400.000	1200.0
4	CENTER	400.000		1400.0
-----	FACE		400.000	1600.0
5	CENTER	400.000		1800.0
-----	FACE		400.000	2000.0
6	CENTER	400.000		2200.0
-----	FACE		400.000	2400.0
7	CENTER	400.000		2600.0
-----	FACE		400.000	2800.0
8	CENTER	400.000		3000.0
-----	FACE		400.000	3200.0
9	CENTER	400.000		3400.0
-----	FACE		400.000	3600.0
10	CENTER	400.000		3800.0
-----	FACE		400.000	4000.0
11	CENTER	400.000		4200.0
-----	FACE		400.000	4400.0
12	CENTER	400.000		4600.0
-----	FACE		400.000	4800.0
13	CENTER	400.000		5000.0
-----	FACE		400.000	5200.0
14	CENTER	400.000		5400.0
-----	FACE		400.000	5600.0
15	CENTER	400.000		5800.0
-----	FACE		400.000	6000.0
16	CENTER	400.000		6200.0
-----	FACE		400.000	6400.0
17	CENTER	400.000		6600.0
-----	FACE		400.000	6800.0
18	CENTER	400.000		7000.0
-----	FACE		400.000	7200.0
19	CENTER	400.000		7400.0
-----	FACE		400.000	7600.0
20	CENTER	400.000		7800.0
-----	FACE		400.000	8000.0
21	CENTER	400.000		8200.0
-----	FACE		400.000	8400.0
22	CENTER	400.000		8600.0
-----	FACE		400.000	8800.0
23	CENTER	400.000		9000.0
-----	FACE		400.000	9200.0
24	CENTER	400.000		9400.0
-----	FACE		400.000	9600.0
25	CENTER	400.000		9800.0
-----	FACE		400.000	10000.0
26	CENTER	400.000		10200.0
-----	FACE		400.000	10400.0
27	CENTER	400.000		10600.0

-----	FACE		400.000	10800.0
28	CENTER	400.000		11000.0
-----	FACE		400.000	11200.0
29	CENTER	400.000		11400.0
-----	FACE		400.000	11600.0
30	CENTER	400.000		11800.0
-----	FACE		400.000	12000.0
31	CENTER	400.000		12200.0
-----	FACE		400.000	12400.0
32	CENTER	400.000		12600.0
-----	FACE		400.000	12800.0
33	CENTER	400.000		13000.0
-----	FACE		400.000	13200.0
34	CENTER	400.000		13400.0
-----	FACE		400.000	13600.0
35	CENTER	400.000		13800.0
-----	FACE		400.000	14000.0
36	CENTER	400.000		14200.0
-----	FACE		400.000	14400.0
37	CENTER	400.000		14600.0
-----	FACE		400.000	14800.0
38	CENTER	400.000		15000.0
-----	FACE		400.000	15200.0
39	CENTER	400.000		15400.0
-----	FACE		400.000	15600.0

Y-DIRECTION: 39 CELLS
DY = 400.00 METERS

CELL INDEX		FACE TO FACE DISTANCES	CENTER-CENTER DISTANCES	DISTANCES FROM ORIGIN
-----	FACE			0.0
1	CENTER	400.000		200.0
-----	FACE		400.000	400.0
2	CENTER	400.000		600.0
-----	FACE		400.000	800.0
3	CENTER	400.000		1000.0
-----	FACE		400.000	1200.0
4	CENTER	400.000		1400.0
-----	FACE		400.000	1600.0
5	CENTER	400.000		1800.0
-----	FACE		400.000	2000.0
6	CENTER	400.000		2200.0
-----	FACE		400.000	2400.0
7	CENTER	400.000		2600.0
-----	FACE		400.000	2800.0
8	CENTER	400.000		3000.0
-----	FACE		400.000	3200.0
9	CENTER	400.000		3400.0
-----	FACE		400.000	3600.0
10	CENTER	400.000		3800.0
-----	FACE		400.000	4000.0
11	CENTER	400.000		4200.0
-----	FACE		400.000	4400.0
12	CENTER	400.000		4600.0
-----	FACE		400.000	4800.0
13	CENTER	400.000		5000.0
-----	FACE		400.000	5200.0
14	CENTER	400.000		5400.0
-----	FACE		400.000	5600.0
15	CENTER	400.000		5800.0

-----	FACE		400.000	6000.0
16	CENTER	400.000		6200.0
-----	FACE		400.000	6400.0
17	CENTER	400.000		6600.0
-----	FACE		400.000	6800.0
18	CENTER	400.000		7000.0
-----	FACE		400.000	7200.0
19	CENTER	400.000		7400.0
-----	FACE		400.000	7600.0
20	CENTER	400.000		7800.0
-----	FACE		400.000	8000.0
21	CENTER	400.000		8200.0
-----	FACE		400.000	8400.0
22	CENTER	400.000		8600.0
-----	FACE		400.000	8800.0
23	CENTER	400.000		9000.0
-----	FACE		400.000	9200.0
24	CENTER	400.000		9400.0
-----	FACE		400.000	9600.0
25	CENTER	400.000		9800.0
-----	FACE		400.000	10000.0
26	CENTER	400.000		10200.0
-----	FACE		400.000	10400.0
27	CENTER	400.000		10600.0
-----	FACE		400.000	10800.0
28	CENTER	400.000		11000.0
-----	FACE		400.000	11200.0
29	CENTER	400.000		11400.0
-----	FACE		400.000	11600.0
30	CENTER	400.000		11800.0
-----	FACE		400.000	12000.0
31	CENTER	400.000		12200.0
-----	FACE		400.000	12400.0
32	CENTER	400.000		12600.0
-----	FACE		400.000	12800.0
33	CENTER	400.000		13000.0
-----	FACE		400.000	13200.0
34	CENTER	400.000		13400.0
-----	FACE		400.000	13600.0
35	CENTER	400.000		13800.0
-----	FACE		400.000	14000.0
36	CENTER	400.000		14200.0
-----	FACE		400.000	14400.0
37	CENTER	400.000		14600.0
-----	FACE		400.000	14800.0
38	CENTER	400.000		15000.0
-----	FACE		400.000	15200.0
39	CENTER	400.000		15400.0
-----	FACE		400.000	15600.0

SHORELINE MODELING SYSTEM (SMS): PC RCPWAVE, VERSION 1.

***** BATHSPEC CARD: SPECIFICATION OF BATHYMETRY/TOPOGRAPHY -

VARIABLE	DESCRIPTION OF USAGE:	VALUE:	NOTES:
BUNITS	SYSTEM OF UNITS FOR DEPTH DATA	METERS	
BSEQ	READ SEQUENCE FOR DEPTH DECK	YX	
WDATUM	DATUM FOR WATER DEPTHS	0.000	
LDATUM	DATUM FOR LAND ELEVATIONS	0.000	
DLIMIT	MAXIMUM DEPTH ALLOWED	-2000.0	
BFORM	FORMAT OF DEPTH DATA		(10F7.1)

```
        NUMBER OF ELEVATION CHANGES =     0
 *****************************************
 *   INPUT PROCESSING COMPLETED:         *
 *   FATAL ERRORS=   0     WARNINGS =   0 *
 *****************************************
                    W A V E   C O N D I T I O N    1

        THE DEEP WATER WAVE PARAMETERS FOR CASE  1 ARE:
                                        HEIGHT =   1.000
                                        PERIOD =   7.000
                                        ANGLE  =   0.000
```

1 WATER DEPTHS (MULTIPLIED BY 10.)

I/J:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1:	10	10	10	10	10	10	10	20	20	30	30	40	50	60	70
2:	10	10	10	10	10	10	10	20	20	30	30	40	50	60	70
3:	20	20	20	20	20	20	20	20	30	30	40	50	60	70	90
4:	20	20	20	20	20	20	20	30	30	40	50	60	70	90	100
5:	30	30	30	30	30	30	30	30	40	50	60	70	90	110	130
6:	30	30	30	30	30	30	30	40	50	60	70	80	100	140	160
7:	40	40	40	40	40	40	40	50	60	60	80	100	100	170	190
8:	50	50	50	50	50	50	50	50	60	70	90	100	170	200	220
9:	50	50	50	50	50	50	50	60	70	90	100	160	200	230	260
10:	60	60	60	60	60	60	60	70	80	100	150	200	240	260	280
11:	60	60	60	60	60	60	70	80	90	120	180	230	260	290	300
12:	70	70	70	70	70	70	80	90	100	160	220	260	290	310	320
13:	80	80	80	80	80	80	90	100	140	200	260	290	310	330	340
14:	90	90	90	90	90	90	100	100	180	260	290	320	340	350	360

1 WATER DEPTHS (MULTIPLIED BY 10.)

I/J:	16	17	18	19	20
1:	80	80	100	100	100
2:	80	80	100	100	100
3:	100	100	120	120	120
4:	130	130	140	140	150
5:	150	160	170	170	180
6:	180	190	200	200	210
7:	210	220	220	230	230
8:	240	250	260	260	260
9:	260	270	280	280	280
10:	290	290	300	300	300
11:	310	310	320	320	320
12:	330	340	340	340	340
13:	350	350	360	360	360
14:	370	380	380	380	380

1 WAVE ANGLES (MULTIPLIED BY 1.)

I/J:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1:	0	0	1	4	10	19	33	41	28	33	26	27	22	18	13
2:	0	0	1	4	10	19	33	41	28	33	26	27	22	18	13
3:	0	0	1	4	11	21	30	33	32	27	28	24	21	17	12
4:	0	0	1	3	9	18	29	34	27	29	24	22	19	15	10
5:	0	0	1	3	9	17	26	30	30	26	23	20	19	13	7
6:	0	0	1	3	7	14	25	31	26	25	21	17	16	11	5
7:	0	0	1	2	6	13	22	28	24	22	21	14	12	9	3
8:	0	0	0	2	6	12	19	23	24	21	17	14	10	3	2
9:	0	0	0	1	5	11	18	23	22	20	15	11	4	2	1
10:	0	0	0	1	4	10	17	20	20	18	13	6	3	1	1
11:	0	0	0	1	3	9	15	17	18	15	9	3	2	1	0

```
     12:       0   0   0   0   2   7  13  14  15  12   5   2   1   0   0
     13:       0   0   0   0   1   6  10  13  13   6   2   1   1   0   0
     14:       0   0   0   0   1   4   7  10   9   3   1   1   0   0   0
1    WAVE ANGLES     (MULTIPLIED BY     1.)
    I/J:      16  17  18  19  20
 ----------------------------------------------------------------------
      1:       7   6   5   1   0
      2:       7   6   5   1   0
      3:       6   4   3   1   0
      4:       6   3   2   1   0
      5:       4   2   1   1   0
      6:       3   1   1   0   0
      7:       2   1   1   0   0
      8:       1   1   0   0   0
      9:       0   0   0   0   0
     10:       0   0   0   0   0
     11:       0   0   0   0   0
     12:       0   0   0   0   0
     13:       0   0   0   0   0
     14:       0   0   0   0   0
1    WAVE HEIGHTS    (MULTIPLIED BY    10.)
    I/J:       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
 ----------------------------------------------------------------------
      1:       4   4   4   4   4   4   4  11   8   9   8   8   8   8   8
      2:       4   4   4   4   4   4   4  11   8   9   8   8   8   8   8
      3:      13  13  14  14   8   8  13   9   8   8   8   8   8   8   8
      4:      12  12  14  15   8   8  14   8   8   8   8   8   8   8   8
      5:      11  11  12  14  15  15  12   9   8   8   8   8   8   8   8
      6:      11  11  12  13  15  15  12   9   8   8   8   8   8   8   8
      7:      10  10  11  12  13  13  12   9   8   8   8   8   8   8   9
      8:      10  10  10  11  13  13  11   9   8   8   8   8   8   9   9
      9:      10  10  10  11  12  12  11   9   8   8   8   8   9   9   9
     10:      10  10  10  10  11  12  11   9   8   8   8   8   9   9  10
     11:      10  10  10  10  11  11  10   9   8   8   8   9   9  10  10
     12:       9   9   9  10  10  11  10   9   8   8   9   9  10  10  10
     13:       9   9   9   9  10  10  10   9   8   9   9  10  10  10  10
     14:       9   9   9   9  10  10   9   9   9   9  10  10  10  10  10
1    WAVE HEIGHTS    (MULTIPLIED BY    10.)
    I/J:      16  17  18  19  20
 ----------------------------------------------------------------------
      1:       8   9   9   9   9
      2:       8   9   9   9   9
      3:       8   9   9   9   9
      4:       8   9   9   9   9
      5:       9   9   9   9   9
      6:       9   9   9   9   9
      7:       9   9   9   9   9
      8:       9   9  10  10  10
      9:      10  10  10  10  10
     10:      10  10  10  10  10
     11:      10  10  10  10  10
     12:      10  10  10  10  10
     13:      10  10  10  10  10
     14:      10  10  10  10  10
1    WAVE NUMBERS    (MULTIPLIED BY 1000.)
    I/J:       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
 ----------------------------------------------------------------------
      1:     291 291 291 291 291 291 291 208 208 173 173 152 138 127 120
      2:     291 291 291 291 291 291 291 208 208 173 173 152 138 127 120
      3:     208 208 208 208 208 208 208 208 173 173 152 138 127 120 109
      4:     208 208 208 208 208 208 208 173 173 152 138 127 120 109 105
```

5:	173	173	173	173	173	173	173	173	152	138	127	120	109	102	97
6:	173	173	173	173	173	173	173	152	138	127	120	114	105	95	91
7:	152	152	152	152	152	152	152	138	127	127	114	105	105	90	88
8:	138	138	138	138	138	138	138	138	127	120	109	105	90	87	86
9:	138	138	138	138	138	138	138	127	120	109	105	91	87	85	84
10:	127	127	127	127	127	127	127	120	114	105	93	87	85	84	84
11:	127	127	127	127	127	127	120	114	109	99	89	85	84	83	83
12:	120	120	120	120	120	120	114	109	105	91	86	84	83	83	83
13:	114	114	114	114	114	114	109	105	95	87	84	83	83	83	83
14:	109	109	109	109	109	109	105	105	89	84	83	83	83	83	83

1 WAVE NUMBERS (MULTIPLIED BY 1000.)

I/J:	16	17	18	19	20
1:	114	114	105	105	105
2:	114	114	105	105	105
3:	105	105	99	99	99
4:	97	97	95	95	93
5:	93	91	90	90	89
6:	89	88	87	87	87
7:	87	86	86	85	85
8:	85	85	84	84	84
9:	84	84	84	84	84
10:	83	83	83	83	83
11:	83	83	83	83	83
12:	83	83	83	83	83
13:	83	83	83	83	83
14:	83	83	83	83	83

1 BREAKING INDEX (CHARACTER INFORMATION; NO MULTIPLIER NEEDED)

I/J:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1:	.	B	B	B	B	B	B	.	.	.	.	.	.	.	.
2:	.	B	B	B	B	B	B	.	.	.	.	.	.	.	.
3:	.	.	.	.	B	B	.	.	.	.	.	.	.	.	.
4:	.	.	.	.	B	B	.	.	.	.	.	.	.	.	.
5:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
8:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
9:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
10:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
11:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
13:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
14:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

1 BREAKING INDEX (CHARACTER INFORMATION; NO MULTIPLIER NEEDED)

I/J:	16	17	18	19	20
1:	.	.	.	.	.
2:	.	.	.	.	.
3:	.	.	.	.	.
4:	.	.	.	.	.
5:	.	.	.	.	.
6:	.	.	.	.	.
7:	.	.	.	.	.
8:	.	.	.	.	.
9:	.	.	.	.	.
10:	.	.	.	.	.
11:	.	.	.	.	.
12:	.	.	.	.	.
13:	.	.	.	.	.
14:	.	.	.	.	.

Sample RCPWAVE output file for nearshore reference line

```
WAVE CONDITION NUMBER  1:   HEIGHT=   1.000   PERIOD=  7.000   ANGLE=   0.000
    1  15    0.9170    0.0021    10.00
    2  15    0.9170    0.0021    10.00
    3  15    0.9180    0.0148    10.00
    4  15    0.9213    0.0784    10.00
    5  15    0.9364    0.3845    10.00
    6  15    0.9545    3.0264    10.00
    7  14    0.9499    7.2079    10.00
    8  13    0.9150   13.0783    10.00
    9  12    0.8439   15.2512    10.00
   10  10    0.7833   18.4944    10.00
   11   9    0.7712   14.9769    10.00
   12   8    0.7929   13.6893    10.00
   13   6    0.7990   16.0897    10.00
   14   5    0.7704   12.6106    11.00
   15   4    0.7988    9.6903    10.00
   16   3    0.8155    6.3878    10.00
   17   3    0.8599    4.4571    10.00
   18   2    0.8559    5.2985    10.00
   19   2    0.8606    1.0599    10.00
   20   2    0.8754    0.0001    10.00
   21   2    0.8606   -1.0598    10.00
   22   2    0.8559   -5.2984    10.00
   23   3    0.8599   -4.4569    10.00
   24   3    0.8155   -6.3877    10.00
   25   4    0.7988   -9.6902    10.00
   26   5    0.7704  -12.6105    11.00
   27   6    0.7990  -16.0896    10.00
   28   8    0.7929  -13.6893    10.00
   29   9    0.7712  -14.9768    10.00
   30  10    0.7833  -18.4943    10.00
   31  12    0.8439  -15.2511    10.00
   32  13    0.9150  -13.0782    10.00
   33  14    0.9499   -7.2078    10.00
   34  15    0.9545   -3.0264    10.00
   35  15    0.9364   -0.3844    10.00
   36  15    0.9213   -0.0783    10.00
   37  15    0.9180   -0.0147    10.00
   38  15    0.9170   -0.0020    10.00
   39  15    0.9170   -0.0020    10.00
```

APPENDIX B:

Sample files with frequency component calculations for one-dimensional spectrum

Maple file for one-dimensional spectrum frequency limits ($T_p = 7$ s)

Constants

```
> Hs:=1:
> g:=9.81:
> Tp:=7:
> fp:=1/Tp;
```

$$fp := \frac{1}{7}$$

```
> lambda:=0.000196:
> Gamma:=3.3:
> sigmaA:=.07:
> sigmaB:=.09:
> alpha:=(1/lambda)*(((Hs*fp^2)/(4*g))^2);
```

$$\alpha := 0.001380046662$$

Define JONSWAP spectra model equation

Case 1: f > fp

```
> s1:=f->((alpha*g^2)/((2*Pi)^4*f^5))*exp(-1.25*(fp/f)^4)*Gamma^(exp(-
(f-fp)^2/(2*sigmaA^2*fp^2)));
```

$$s1 := f \to \frac{\alpha g^2 e^{\left(-1.25 \frac{fp^4}{f^4}\right)} \Gamma^{\left(e^{\left(-\frac{(f-fp)^2}{2\, sigmaA^2\, fp^2}\right)}\right)}}{16 \pi^4 f^5}$$

Check energy density at spectral peak

```
> simplify(s1(fp));
```

$$1.354092554$$

Case 2: f < fp

```
> s2:=f->((alpha*g^2)/((2*Pi)^4*f^5))*exp(-1.25*(fp/f)^4)*Gamma^(exp(-
(f-fp)^2/(2*sigmaB^2*fp^2)));
```

$$s2 := f \to \frac{\alpha g^2 e^{\left(-1.25 \frac{fp^4}{f^4}\right)} \Gamma^{\left(e^{\left(-\frac{(f-fp)^2}{2\, sigmaB^2\, fp^2}\right)}\right)}}{16 \pi^4 f^5}$$

Check energy density at spectral peak

```
> simplify(s2(fp));
```

$$1.354092554$$

Total spectral energy

```
> Mo:=evalf(Int(s1(f),f = .6*fp..fp))+evalf(Int(s 2(f),f = fp..3*fp));
```

$$Mo := 0.06177144931$$

Spectral energy of each frequency component

```
> DeltaMo:=Mo/10;
```

$$DeltaMo := 0.006177144931$$

Establish frequency limits for each frequency band (interval) such that component energy = DeltaMo

```
> Interval1:=evalf(Int(s1(f),f = .6*fp..0.1271));
```

$$Interval1 := 0.006149152207$$

```
> Interval2:=evalf(Int(s1(f),f = .1271..0.1357));
```

$$Interval2 := 0.006194672929$$

```
> Interval3:=evalf(Int(s1(f),f = .1357..0.1409));
```

$$Interval3 := 0.006143179828$$

```
> Interval4a:=evalf(Int(s1(f),f = .1409..fp));
```

$$Interval4a := 0.002628529950$$

```
> Interval4b:=evalf(Int(s2(f),f = fp..0.1455));
```

$$Interval4b := 0.003545105564$$

```
> Interval4:=Interval4a+Interval4b;
```

$$Interval4 := 0.006173635514$$

```
> Interval5:=evalf(Int(s2(f),f = 0.1455..0.1506));
```

$$Interval5 := 0.006181062455$$

```
> Interval6:=evalf(Int(s2(f),f = 0.1506..0.1576));
```

$$Interval6 := 0.006185363119$$

```
> Interval7:=evalf(Int(s2(f),f = .1576..0.17));
```

$$Interval7 := 0.006182522307$$

```
> Interval8:=evalf(Int(s2(f),f = 0.17..0.1920));
```

$$Interval8 := 0.006164965433$$

```
> Interval9:=evalf(Int(s2(f),f = 0.1920..0.2309));
```

$$Interval9 := 0.006175089401$$

```
> Interval10:=evalf(Int(s2(f),f = 0.2309..3*fp));
```

$$Interval10 := 0.006221806116$$

Mathcad file for one-dimensional spectrum representative frequencies ($T_p = 7$ s)

Constants

$Hs := 1m$

$g := 9.81g$

$Tp := 7s$

$fp := \frac{1}{Tp}$ $\qquad fp = 0.1429s^{-1}$

$fmin := 0.6 \cdot fp$ $\qquad fmin = 0.0857s^{-1}$

$fmax := 3 \cdot fp$ $\qquad fmax = 0.4286s^{-1}$

$finf := 100 \cdot fp$ $\qquad finf = 14.2857s^{-1}$

**when used in a numerical expression, MathCAD uses 10^307 for infinity. for system w/ units, integral can not be carried out with this as upper limit since infinity has no units. this value of finf approaches value when inifinty is used w/o the units.*

$\lambda := 0.000196$

$\gamma := 3.3$

$\sigma a := 0.07$ $\qquad f < fp$

$\sigma b := 0.09$ $\qquad f > fp$

$$\alpha := \left[\frac{1}{\lambda} \cdot \left(\frac{Hs \cdot fp^2}{4 \cdot g}\right)^2\right] \qquad \alpha = 1.3810\times 10^{-3}$$

Define JONSWAP spectral model equation, T = 7 sec

Case 1: f < fp

$$S1(f) := \left[\frac{\alpha \cdot g^2}{(2 \cdot \pi)^4 \cdot f^5}\right] \cdot e^{\left[-1.25 \left(\frac{fp}{f}\right)^4\right]} \cdot \gamma^{e^{\left[-\left[\frac{(f-fp)^2}{2 \cdot \sigma a^2 \cdot fp^2}\right]\right]}}$$

Check S(f) at f = fp : $\qquad S1(fp) = 1.3541m^2 s$

Case 2: f > fp

$$S2(f) := \left[\frac{\alpha \cdot g^2}{(2\cdot\pi)^4 \cdot f^5}\right] \cdot e^{\left[-1.25\cdot\left(\frac{fp}{f}\right)^4\right]} \cdot \gamma^{e^{\left[-\left[\frac{(f-fp)^2}{2\cdot\sigma b^2\cdot fp^2}\right]\right]}}$$

Check S(f) at f = fp : $S2(fp) = 1.3541\,m^2 s$

Total wave energy, m_0

Case 1: f < fp

$$mo1 := \int_{fmin}^{fp} S1(f)\,df \qquad mo1 = 0.0211\,m^2$$

Case 2: f > fp

$$mo2 := \int_{fp}^{fmax} S2(f)\,df \qquad mo2 = 0.0407\,m^2$$

Total wave energy

$$mo := mo1 + mo2 \qquad mo = 0.0618\,m^2$$

Check validity of frequency limits

$$mo\_fmin := \int_{0}^{fmin} S1(f)\,df \qquad mo\_fmin = 2.6493\times 10^{-6}\,m^2$$

$$\left(\frac{mo\_fmin}{mo}\right) = 0.0043\%$$

$$mo\_fmax := \int_{fmax}^{finf} S2(f)\,df \qquad mo\_fmax = 6.2663\times 10^{-4}\,m^2$$

$$\left(\frac{mo\_fmax}{mo}\right) = 1.0144\%$$

Representative Frequencies , f_i , for frequency bands (intervals)

$\Delta E := 10$ $\quad$ $moi := \frac{mo}{\Delta E}$ $\quad$ $moi = 0.00618m^2$

Interval 1: f -> 0.6fp - 0.1271

$$f1 := \frac{\int_{fmin}^{0.1271Hz} f \cdot S1(f)\,df}{\int_{fmin}^{0.1271Hz} S1(f)\,df} \qquad f1 = 0.1171s^{-1}$$

$T1 := f1^{-1}$ ---> $T1 = 8.5413s$

Interval 2: f ->0.1271 - 0.1357

$$f2 := \frac{\int_{0.1271Hz}^{0.1357Hz} f \cdot S1(f)\,df}{\int_{0.1271Hz}^{0.1357Hz} S1(f)\,df} \qquad f2 = 0.1319s^{-1}$$

$T2 := f2^{-1}$ ---> $T2 = 7.5807s$

Interval 3: f ->0.1357 - 0.1409

$$f3 := \frac{\int_{0.1357Hz}^{0.1409Hz} f \cdot S1(f)\,df}{\int_{0.1357Hz}^{0.1409Hz} S1(f)\,df} \qquad f3 = 0.1384s^{-1}$$

$T3 := f3^{-1}$ ---> $T3 = 7.2245s$

Interval 4: f ->0.1409 - 0.1455

$$f4 := \frac{\int_{0.1409Hz}^{fp} f \cdot S1(f)\,df + \int_{fp}^{0.1455Hz} f \cdot S2(f)\,df}{\int_{0.1409Hz}^{fp} S1(f)\,df + \int_{fp}^{0.1455Hz} S2(f)\,df} \qquad f4 = 0.1432s^{-1}$$

$T4 := f4^{-1}$ ---> $T4 = 6.9834s$

Interval 5: f ->0.1455 - 0.1506

$$f5 := \frac{\int_{0.1455Hz}^{0.1506Hz} f \cdot S2(f)\, df}{\int_{0.1455Hz}^{0.1506Hz} S2(f)\, df} \qquad f5 = 0.1480s^{-1}$$

$$T5 := f5^{-1} \quad \text{--->} \quad T5 = 6.7583s$$

Interval 6: f ->0.1506 - 0.1576

$$f6 := \frac{\int_{0.1506Hz}^{0.1576Hz} f \cdot S2(f)\, df}{\int_{0.1506Hz}^{0.1576Hz} S2(f)\, df} \qquad f6 = 0.1538s^{-1}$$

$$T6 := f6^{-1} \quad \text{--->} \quad T6 = 6.5001s$$

Interval 7: f ->0.1576 - 0.1700

$$f7 := \frac{\int_{0.1576Hz}^{0.1700Hz} f \cdot S2(f)\, df}{\int_{0.1576Hz}^{0.1700Hz} S2(f)\, df} \qquad f7 = 0.1631s^{-1}$$

$$T7 := f7^{-1} \quad \text{--->} \quad T7 = 6.1304s$$

Interval 8: f ->0.1700 - 0.1920

$$f8 := \frac{\int_{0.1700Hz}^{0.1920Hz} f \cdot S2(f)\, df}{\int_{0.1700Hz}^{0.1920Hz} S2(f)\, df} \qquad f8 = 0.1801s^{-1}$$

$$T8 := f8^{-1} \quad \text{--->} \quad T8 = 5.5518s$$

Interval 9: f ->0.1920 - 0.2309

$$f9 := \frac{\int_{0.1920Hz}^{0.2309Hz} f \cdot S2(f)\, df}{\int_{0.1920Hz}^{0.2309Hz} S2(f)\, df} \qquad f9 = 0.2091s^{-1}$$

$$T9 := f9^{-1} \quad \text{--->} \quad T9 = 4.7819s$$

Interval 10: f ->0.2309 - 3fp

$$f10 := \frac{\int_{0.2309Hz}^{fmax} f \cdot S2(f)\, df}{\int_{0.2309Hz}^{fmax} S2(f)\, df} \qquad f10 = 0.2858s^{-1}$$

$$T10 := f10^{-1} \quad \text{--->} \quad T10 = 3.4995s$$

Representative Deep Water Wave Height, H_{oi}

$$Hoi := 4 \cdot \sqrt{moi} \quad \text{--->} \quad Hoi = 0.3144m$$

*since the relative energy of each component wave is equal, the equivalent monochromatic wave height should be the same for each frequency interval

APPENDIX C:

Deep water wave conditions for spectral components used as input for RCPWAVE

Table C.1. Deep water wave conditions for 1-D spectral components ($T_p = 7$ s)

1-D DEEP WATER WAVE CONDITIONS (T_p = 7s)			
Frequency Bands			
Band No.	T_i [s]	H_{moi} [m]	Θ_{oi} [°]
1	8.5413	0.3144	0.0000
2	7.5807	0.3144	0.0000
3	7.2245	0.3144	0.0000
4	6.9834	0.3144	0.0000
5	6.7583	0.3144	0.0000
6	6.5001	0.3144	0.0000
7	6.1304	0.3144	0.0000
8	5.5518	0.3144	0.0000
9	4.7819	0.3144	0.0000
10	3.4995	0.3144	0.0000

Table C.2. Deep water wave conditions for 1-D spectral components ($T_p = 10$ s)

1-D DEEP WATER WAVE CONDITIONS (T_p = 10s)			
Frequency Bands			
Band No.	T_i [s]	H_{moi} [m]	Θ_{oi} [°]
1	12.1982	0.3144	0.0000
2	10.8275	0.3144	0.0000
3	10.3162	0.3144	0.0000
4	9.9704	0.3144	0.0000
5	9.6488	0.3144	0.0000
6	9.2790	0.3144	0.0000
7	8.7507	0.3144	0.0000
8	7.9220	0.3144	0.0000
9	6.8190	0.3144	0.0000
10	4.9906	0.3144	0.0000

Table C.3. Deep water wave conditions for 2-D spectral components using cosine-squared spreading function (T_p = 7 s)

2-D (Cosine-Squared Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj} [°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105
2	-75	0.0008	0.0275	0.0008	0.0276	0.0008	0.0275	0.0008	0.0276	0.0008	0.0276
3	-65	0.0020	0.0444	0.0020	0.0446	0.0020	0.0444	0.0020	0.0445	0.0020	0.0445
4	-55	0.0036	0.0600	0.0037	0.0603	0.0036	0.0600	0.0037	0.0602	0.0037	0.0602
5	-45	0.0055	0.0739	0.0056	0.0742	0.0055	0.0739	0.0056	0.0741	0.0056	0.0741
6	-35	0.0074	0.0856	0.0075	0.0859	0.0074	0.0855	0.0074	0.0858	0.0075	0.0858
7	-25	0.0091	0.0947	0.0091	0.0950	0.0091	0.0946	0.0091	0.0949	0.0091	0.0949
8	-15	0.0103	0.1009	0.0104	0.1012	0.0103	0.1008	0.0103	0.1011	0.0103	0.1011
9	-5	0.0109	0.1040	0.0110	0.1044	0.0109	0.1040	0.0110	0.1042	0.0110	0.1043
10	5	0.0109	0.1040	0.0110	0.1044	0.0109	0.1040	0.0110	0.1042	0.0110	0.1043
11	15	0.0103	0.1009	0.0104	0.1012	0.0103	0.1008	0.0103	0.1011	0.0103	0.1011
12	25	0.0091	0.0947	0.0091	0.0950	0.0091	0.0946	0.0091	0.0949	0.0091	0.0949
13	35	0.0074	0.0856	0.0075	0.0859	0.0074	0.0855	0.0074	0.0858	0.0075	0.0858
14	45	0.0055	0.0739	0.0056	0.0742	0.0055	0.0739	0.0056	0.0741	0.0056	0.0741
15	55	0.0036	0.0600	0.0037	0.0603	0.0036	0.0600	0.0037	0.0602	0.0037	0.0602
16	65	0.0020	0.0444	0.0020	0.0446	0.0020	0.0444	0.0020	0.0445	0.0020	0.0445
17	75	0.0008	0.0275	0.0008	0.0276	0.0008	0.0275	0.0008	0.0276	0.0008	0.0276
18	85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105

2-D (Cosine-Squared Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj} [°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0106
2	-75	0.0008	0.0276	0.0008	0.0276	0.0008	0.0275	0.0008	0.0276	0.0008	0.0277
3	-65	0.0020	0.0445	0.0020	0.0445	0.0020	0.0444	0.0020	0.0445	0.0020	0.0446
4	-55	0.0037	0.0602	0.0037	0.0602	0.0037	0.0601	0.0037	0.0602	0.0037	0.0604
5	-45	0.0056	0.0741	0.0056	0.0741	0.0055	0.0740	0.0056	0.0741	0.0056	0.0744
6	-35	0.0075	0.0858	0.0075	0.0858	0.0074	0.0857	0.0074	0.0858	0.0075	0.0861
7	-25	0.0091	0.0949	0.0091	0.0949	0.0091	0.0948	0.0091	0.0949	0.0092	0.0952
8	-15	0.0104	0.1012	0.0104	0.1011	0.0103	0.1010	0.0103	0.1011	0.0104	0.1015
9	-5	0.0110	0.1043	0.0110	0.1043	0.0110	0.1042	0.0110	0.1042	0.0111	0.1046
10	5	0.0110	0.1043	0.0110	0.1043	0.0110	0.1042	0.0110	0.1042	0.0111	0.1046
11	15	0.0104	0.1012	0.0104	0.1011	0.0103	0.1010	0.0103	0.1011	0.0104	0.1015
12	25	0.0091	0.0949	0.0091	0.0949	0.0091	0.0948	0.0091	0.0949	0.0092	0.0952
13	35	0.0075	0.0858	0.0075	0.0858	0.0074	0.0857	0.0074	0.0858	0.0075	0.0861
14	45	0.0056	0.0741	0.0056	0.0741	0.0055	0.0740	0.0056	0.0741	0.0056	0.0744
15	55	0.0037	0.0602	0.0037	0.0602	0.0037	0.0601	0.0037	0.0602	0.0037	0.0604
16	65	0.0020	0.0445	0.0020	0.0445	0.0020	0.0444	0.0020	0.0445	0.0020	0.0446
17	75	0.0008	0.0276	0.0008	0.0276	0.0008	0.0275	0.0008	0.0276	0.0008	0.0277
18	85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0106

Table C.4. Deep water wave conditions for 2-D spectral components using cosine-squared spreading function (T_p = 10 s)

2-D (Cosine-Squared Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0106	0.0001	0.0105	0.0001	0.0106
2	-75	0.0008	0.0275	0.0008	0.0276	0.0008	0.0277	0.0008	0.0275	0.0008	0.0276
3	-65	0.0020	0.0445	0.0020	0.0445	0.0020	0.0448	0.0020	0.0443	0.0020	0.0446
4	-55	0.0037	0.0602	0.0037	0.0602	0.0037	0.0606	0.0036	0.0600	0.0037	0.0603
5	-45	0.0055	0.0741	0.0056	0.0742	0.0056	0.0746	0.0055	0.0738	0.0056	0.0743
6	-35	0.0074	0.0857	0.0075	0.0859	0.0075	0.0864	0.0074	0.0855	0.0075	0.0860
7	-25	0.0091	0.0948	0.0091	0.0950	0.0092	0.0955	0.0090	0.0946	0.0092	0.0951
8	-15	0.0103	0.1010	0.0104	0.1012	0.0105	0.1018	0.0103	0.1008	0.0104	0.1014
9	-5	0.0110	0.1042	0.0110	0.1044	0.0111	0.1050	0.0109	0.1039	0.0111	0.1045
10	5	0.0110	0.1042	0.0110	0.1044	0.0111	0.1050	0.0109	0.1039	0.0111	0.1045
11	15	0.0103	0.1010	0.0104	0.1012	0.0105	0.1018	0.0103	0.1008	0.0104	0.1014
12	25	0.0091	0.0948	0.0091	0.0950	0.0092	0.0955	0.0090	0.0946	0.0092	0.0951
13	35	0.0074	0.0857	0.0075	0.0859	0.0075	0.0864	0.0074	0.0855	0.0075	0.0860
14	45	0.0055	0.0741	0.0056	0.0742	0.0056	0.0746	0.0055	0.0738	0.0056	0.0743
15	55	0.0037	0.0602	0.0037	0.0602	0.0037	0.0606	0.0036	0.0600	0.0037	0.0603
16	65	0.0020	0.0445	0.0020	0.0445	0.0020	0.0448	0.0020	0.0443	0.0020	0.0446
17	75	0.0008	0.0275	0.0008	0.0276	0.0008	0.0277	0.0008	0.0275	0.0008	0.0276
18	85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0106	0.0001	0.0105	0.0001	0.0106

2-D (Cosine-Squared Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105
2	-75	0.0008	0.0275	0.0008	0.0275	0.0008	0.0276	0.0008	0.0275	0.0008	0.0275
3	-65	0.0020	0.0444	0.0020	0.0444	0.0020	0.0445	0.0020	0.0445	0.0020	0.0444
4	-55	0.0036	0.0600	0.0037	0.0601	0.0037	0.0602	0.0037	0.0601	0.0037	0.0601
5	-45	0.0055	0.0739	0.0055	0.0740	0.0056	0.0741	0.0055	0.0740	0.0055	0.0740
6	-35	0.0074	0.0855	0.0074	0.0856	0.0074	0.0858	0.0074	0.0857	0.0074	0.0857
7	-25	0.0091	0.0946	0.0091	0.0947	0.0091	0.0949	0.0091	0.0948	0.0091	0.0948
8	-15	0.0103	0.1008	0.0103	0.1009	0.0103	0.1011	0.0103	0.1010	0.0103	0.1010
9	-5	0.0109	0.1040	0.0110	0.1041	0.0110	0.1043	0.0110	0.1042	0.0110	0.1042
10	5	0.0109	0.1040	0.0110	0.1041	0.0110	0.1043	0.0110	0.1042	0.0110	0.1042
11	15	0.0103	0.1008	0.0103	0.1009	0.0103	0.1011	0.0103	0.1010	0.0103	0.1010
12	25	0.0091	0.0946	0.0091	0.0947	0.0091	0.0949	0.0091	0.0948	0.0091	0.0948
13	35	0.0074	0.0855	0.0074	0.0856	0.0074	0.0858	0.0074	0.0857	0.0074	0.0857
14	45	0.0055	0.0739	0.0055	0.0740	0.0056	0.0741	0.0055	0.0740	0.0055	0.0740
15	55	0.0036	0.0600	0.0037	0.0601	0.0037	0.0602	0.0037	0.0601	0.0037	0.0601
16	65	0.0020	0.0444	0.0020	0.0444	0.0020	0.0445	0.0020	0.0445	0.0020	0.0444
17	75	0.0008	0.0275	0.0008	0.0275	0.0008	0.0276	0.0008	0.0275	0.0008	0.0275
18	85	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105	0.0001	0.0105

Table C.5. Deep water wave conditions for 2-D spectral components using Mitsuyasu spreading function (T_p = 7 s)

2-D (Mitsuyasu Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj} [°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	0.0001	0.0120	1.E-06	0.0011	9.E-08	0.0003	2.E-08	0.0001	3.E-08	0.0002
2	-75	0.0003	0.0186	1.E-05	0.0035	2.E-06	0.0013	5.E-07	0.0007	8.E-07	0.0009
3	-65	0.0008	0.0282	0.0001	0.0090	2.E-05	0.0045	8.E-06	0.0028	1.E-05	0.0035
4	-55	0.0017	0.0415	0.0004	0.0201	0.0002	0.0125	9.E-05	0.0092	0.0001	0.0106
5	-45	0.0034	0.0584	0.0015	0.0387	0.0008	0.0289	0.0006	0.0239	0.0007	0.0262
6	-35	0.0061	0.0776	0.0042	0.0648	0.0031	0.0557	0.0026	0.0504	0.0028	0.0530
7	-25	0.0095	0.0968	0.0091	0.0951	0.0083	0.0904	0.0077	0.0875	0.0080	0.0891
8	-15	0.0128	0.1124	0.0152	0.1225	0.0157	0.1246	0.0160	0.1258	0.0159	0.1255
9	-5	0.0148	0.1212	0.0195	0.1390	0.0216	0.1461	0.0230	0.1507	0.0224	0.1488
10	5	0.0148	0.1212	0.0195	0.1390	0.0216	0.1461	0.0230	0.1507	0.0224	0.1488
11	15	0.0128	0.1124	0.0152	0.1225	0.0157	0.1246	0.0160	0.1258	0.0159	0.1255
12	25	0.0095	0.0968	0.0091	0.0951	0.0083	0.0904	0.0077	0.0875	0.0080	0.0891
13	35	0.0061	0.0776	0.0042	0.0648	0.0031	0.0557	0.0026	0.0504	0.0028	0.0530
14	45	0.0034	0.0584	0.0015	0.0387	0.0008	0.0289	0.0006	0.0239	0.0007	0.0262
15	55	0.0017	0.0415	0.0004	0.0201	0.0002	0.0125	0.0001	0.0092	0.0001	0.0106
16	65	0.0008	0.0282	0.0001	0.0090	2.E-05	0.0045	8.E-06	0.0028	1.E-05	0.0035
17	75	0.0003	0.0186	1.E-05	0.0035	2.E-06	0.0013	5.E-07	0.0007	8.E-07	0.0009
18	85	0.0001	0.0120	1.E-06	0.0011	9.E-08	0.0003	2.E-08	0.0001	3.E-08	0.0002

2-D (Mitsuyasu Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj} [°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	1.E-07	0.0003	6.E-07	0.0007	5.E-06	0.0023	6.E-05	0.0074	0.0008	0.0278
2	-75	2.E-06	0.0014	7.E-06	0.0026	4.E-05	0.0059	0.0002	0.0142	0.0014	0.0366
3	-65	2.E-05	0.0048	6.E-05	0.0074	0.0002	0.0133	0.0006	0.0247	0.0022	0.0470
4	-55	0.0002	0.0132	0.0003	0.0177	0.0007	0.0261	0.0016	0.0394	0.0035	0.0586
5	-45	0.0009	0.0300	0.0013	0.0358	0.0021	0.0454	0.0034	0.0578	0.0051	0.0707
6	-35	0.0033	0.0569	0.0039	0.0624	0.0050	0.0701	0.0062	0.0782	0.0069	0.0824
7	-25	0.0084	0.0914	0.0089	0.0940	0.0095	0.0968	0.0097	0.0979	0.0087	0.0925
8	-15	0.0157	0.1248	0.0154	0.1234	0.0145	0.1198	0.0131	0.1137	0.0101	0.1000
9	-5	0.0215	0.1457	0.0201	0.1410	0.0179	0.1332	0.0152	0.1224	0.0109	0.1040
10	5	0.0215	0.1457	0.0201	0.1410	0.0179	0.1332	0.0152	0.1224	0.0109	0.1040
11	15	0.0157	0.1248	0.0154	0.1234	0.0145	0.1198	0.0131	0.1137	0.0101	0.1000
12	25	0.0084	0.0914	0.0089	0.0940	0.0095	0.0968	0.0097	0.0979	0.0087	0.0925
13	35	0.0033	0.0569	0.0039	0.0624	0.0050	0.0701	0.0062	0.0782	0.0069	0.0824
14	45	0.0009	0.0300	0.0013	0.0358	0.0021	0.0454	0.0034	0.0578	0.0051	0.0707
15	55	0.0002	0.0132	0.0003	0.0177	0.0007	0.0261	0.0016	0.0394	0.0035	0.0586
16	65	2.E-05	0.0048	0.0001	0.0074	0.0002	0.0133	0.0006	0.0247	0.0022	0.0470
17	75	2.E-06	0.0014	7.E-06	0.0026	4.E-05	0.0059	0.0002	0.0142	0.0014	0.0366
18	85	1.E-07	0.0003	6.E-07	0.0007	5.E-06	0.0023	0.0001	0.0074	0.0008	0.0278

Table C.6. Deep water wave conditions for 2-D spectral components using Mitsuyasu spreading function (T_p = 10 s)

2-D (Mitsuyasu Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	0.0001	0.0120	1.E-06	0.0011	9.E-08	0.0003	2.E-08	0.0001	4.E-08	0.0002
2	-75	0.0003	0.0186	1.E-05	0.0035	2.E-06	0.0013	5.E-07	0.0007	9.E-07	0.0009
3	-65	0.0008	0.0282	0.0001	0.0090	2.E-05	0.0045	8.E-06	0.0028	1.E-05	0.0035
4	-55	0.0017	0.0415	0.0004	0.0201	0.0002	0.0126	0.0001	0.0091	0.0001	0.0107
5	-45	0.0035	0.0584	0.0015	0.0386	0.0009	0.0291	0.0006	0.0238	0.0007	0.0263
6	-35	0.0061	0.0777	0.0042	0.0647	0.0032	0.0561	0.0026	0.0503	0.0029	0.0532
7	-25	0.0095	0.0969	0.0091	0.0950	0.0084	0.0913	0.0077	0.0872	0.0081	0.0894
8	-15	0.0128	0.1126	0.0152	0.1225	0.0160	0.1258	0.0159	0.1254	0.0160	0.1258
9	-5	0.0149	0.1214	0.0195	0.1390	0.0220	0.1475	0.0228	0.1502	0.0225	0.1491
10	5	0.0149	0.1214	0.0195	0.1390	0.0220	0.1475	0.0228	0.1502	0.0225	0.1491
11	15	0.0128	0.1126	0.0152	0.1225	0.0160	0.1258	0.0159	0.1254	0.0160	0.1258
12	25	0.0095	0.0969	0.0091	0.0950	0.0084	0.0913	0.0077	0.0872	0.0081	0.0894
13	35	0.0061	0.0777	0.0042	0.0647	0.0032	0.0561	0.0026	0.0503	0.0029	0.0532
14	45	0.0035	0.0584	0.0015	0.0386	0.0009	0.0291	0.0006	0.0238	0.0007	0.0263
15	55	0.0017	0.0415	0.0004	0.0201	0.0002	0.0126	0.0001	0.0091	0.0001	0.0107
16	65	0.0008	0.0282	0.0001	0.0090	2.E-05	0.0045	8.E-06	0.0028	1.E-05	0.0035
17	75	0.0003	0.0186	1.E-05	0.0035	2.E-06	0.0013	5.E-07	0.0007	9.E-07	0.0009
18	85	0.0001	0.0120	1.E-06	0.0011	9.E-08	0.0003	2.E-08	0.0001	4.E-08	0.0002

2-D (Mitsuyasu Function) DEEP WATER WAVE CONDITIONS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]	ΔE_{ij}	H_{moij} [m]
1	-85	1.E-07	0.0003	6.E-07	0.0008	5.E-06	0.0023	6.E-05	0.0075	0.0008	0.0278
2	-75	2.E-06	0.0014	7.E-06	0.0026	4.E-05	0.0060	0.0002	0.0143	0.0014	0.0366
3	-65	2.E-05	0.0048	6.E-05	0.0074	0.0002	0.0134	0.0006	0.0249	0.0022	0.0469
4	-55	0.0002	0.0132	0.0003	0.0177	0.0007	0.0263	0.0016	0.0396	0.0035	0.0584
5	-45	0.0009	0.0300	0.0013	0.0358	0.0021	0.0455	0.0034	0.0579	0.0050	0.0705
6	-35	0.0033	0.0568	0.0039	0.0623	0.0050	0.0703	0.0062	0.0783	0.0068	0.0820
7	-25	0.0084	0.0911	0.0089	0.0939	0.0095	0.0969	0.0097	0.0979	0.0086	0.0921
8	-15	0.0156	0.1243	0.0153	0.1229	0.0145	0.1198	0.0130	0.1135	0.0100	0.0995
9	-5	0.0213	0.1451	0.0200	0.1406	0.0179	0.1332	0.0151	0.1222	0.0108	0.1034
10	5	0.0213	0.1451	0.0200	0.1406	0.0179	0.1332	0.0151	0.1222	0.0108	0.1034
11	15	0.0156	0.1243	0.0153	0.1229	0.0145	0.1198	0.0130	0.1135	0.0100	0.0995
12	25	0.0084	0.0911	0.0089	0.0939	0.0095	0.0969	0.0097	0.0979	0.0086	0.0921
13	35	0.0033	0.0568	0.0039	0.0623	0.0050	0.0703	0.0062	0.0783	0.0068	0.0820
14	45	0.0009	0.0300	0.0013	0.0358	0.0021	0.0455	0.0034	0.0579	0.0050	0.0705
15	55	0.0002	0.0132	0.0003	0.0177	0.0007	0.0263	0.0016	0.0396	0.0035	0.0584
16	65	2.E-05	0.0048	0.0001	0.0074	0.0002	0.0134	0.0006	0.0249	0.0022	0.0469
17	75	2.E-06	0.0014	7.E-06	0.0026	4.E-05	0.0060	0.0002	0.0143	0.0014	0.0366
18	85	1.E-07	0.0003	6.E-07	0.0008	5.E-06	0.0023	0.0001	0.0075	0.0008	0.0278

APPENDIX D:

Sample files with spectral component calculations for a two-dimensional spectrum

Definition of cosine-squared function used to calculate spectral components in Mathcad

Define cosine-squared spreading function

$$G(\theta) := \frac{2}{\pi} \cdot (\cos(\theta))^2$$

$$\theta min := \frac{-\pi}{2} \qquad \theta max := \frac{\pi}{2}$$

$$\int_{\theta min}^{\theta max} G(\theta)\, d\theta = 1.0000$$

Total wave energy, m_0

Case 1: f < fp

$$mo1 := \int_{fmin}^{fp} \left(\int_{\theta min}^{\theta max} S1(f) \cdot G(\theta)\, d\theta \right) df \qquad mo1 = 0.0211$$

Case 2: f > fp

$$mo2 := \int_{fp}^{fmax} \left(\int_{\theta min}^{\theta max} S2(f) \cdot G(\theta)\, d\theta \right) df \qquad mo2 = 0.0407$$

Total wave energy

$$mo := mo1 + mo2 \qquad mo = 0.0618$$

Mathcad file for spectral components of first frequency band using Mitsuyasu function ($T_p = 7$ s)

Define Mitsuyasu spreading function, T = 7 sec

$$G(\theta) := G(s) \cdot \left(\cos\left(\frac{\theta}{2}\right)\right)^{2s} \qquad \theta min := \frac{-\pi}{2} \qquad \theta max := \frac{\pi}{2}$$

$$G(s) := \frac{2^{2s-1}}{\pi} \cdot \frac{(\Gamma(s+1))^2}{\Gamma(2s+1)}$$

$$smax := 25$$

$$s1(f) := smax \cdot \left(\frac{f}{fp}\right)^5 \qquad f < fp$$

$$s2(f) := smax \cdot \left(\frac{f}{fp}\right)^{-2.5} \qquad f > fp$$

Define Spreading Function for Both Cases

Case 1: f < fp

$$G1(f,\theta) := \frac{2^{2\,s1(f)-1}}{\pi} \cdot \frac{(\Gamma(s1(f)+1))^2}{\Gamma(2\,s1(f)+1)} \cdot \left(\cos\left(\frac{\theta}{2}\right)\right)^{2\,s1(f)}$$

Case 2: f > fp

$$G2(f,\theta) := \frac{2^{2\,s2(f)-1}}{\pi} \cdot \frac{(\Gamma(s2(f)+1))^2}{\Gamma(2\,s2(f)+1)} \cdot \left(\cos\left(\frac{\theta}{2}\right)\right)^{2\,s2(f)}$$

Total wave energy, m_0

Case 1: f < fp

$$mo1 := \int_{fmin}^{fp} \left(\int_{\theta min}^{\theta max} S1(f) \cdot G1(f,\theta)\, d\theta\right) df \qquad mo1 = 0.0211$$

Case 2: f > fp

$$mo2 := \int_{fp}^{fmax} \left(\int_{\theta min}^{\theta max} S2(f) \cdot G2(f,\theta)\, d\theta\right) df \qquad mo2 := .0407$$

Total wave energy

$$mo := mo1 + mo2 \qquad mo = 0.0618$$

Relative Energies -> Representative Heights, H_i

Interval 1: f -> 0.6fp - 0.1271

$$\Delta E11 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-90\frac{\pi}{180}}^{-80\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$$\Delta E11 = 1.4531\times 10^{-4}$$

$$H11 := 4 \cdot \sqrt{mo \cdot \Delta E11} \qquad H11 = 0.0120$$

$$\theta 11 := -85$$

$$\Delta E12 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-80\frac{\pi}{180}}^{-70\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$$\Delta E12 = 3.4924\times 10^{-4}$$

$$H12 := 4 \cdot \sqrt{mo \cdot \Delta E12} \qquad H12 = 0.0186$$

$$\theta 12 := -75$$

$$\Delta E13 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-70\frac{\pi}{180}}^{-60\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$$\Delta E13 = 8.0439\times 10^{-4}$$

$$H13 := 4 \cdot \sqrt{mo \cdot \Delta E13} \qquad H13 = 0.0282$$

$$\theta 13 := -65$$

$$\Delta E14 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-60\frac{\pi}{180}}^{-50\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$$\Delta E14 = 1.7399\times 10^{-3}$$

$$H14 := 4 \cdot \sqrt{mo \cdot \Delta E14} \qquad H14 = 0.0415$$

$$\theta 14 := -55$$

$$\Delta E15 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-50\frac{\pi}{180}}^{-40\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$\Delta E15 = 3.4441 \times 10^{-3}$

$H15 := 4 \cdot \sqrt{mo \cdot \Delta E15}$ $\quad H15 = 0.0584$

$\theta 15 := -45$

$$\Delta E16 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-40\frac{\pi}{180}}^{-30\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$\Delta E16 = 6.0935 \times 10^{-3}$

$H16 := 4 \cdot \sqrt{mo \cdot \Delta E16}$ $\quad H16 = 0.0776$

$\theta 16 := -35$

$$\Delta E17 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-30\frac{\pi}{180}}^{-20\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$\Delta E17 = 9.4664 \times 10^{-3}$

$H17 := 4 \cdot \sqrt{mo \cdot \Delta E17}$ $\quad H17 = 0.0968$

$\theta 17 := -25$

$$\Delta E18 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-20\frac{\pi}{180}}^{-10\frac{\pi}{180}} S1(f) \cdot G1(f,\theta)\, d\theta \right) df}{mo}$$

$\Delta E18 = 0.0128$

$H18 := 4 \cdot \sqrt{mo \cdot \Delta E18}$ $\quad H18 = 0.1124$

$\theta 18 := -15$

$$\Delta E19 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{-10\cdot\frac{\pi}{180}}^{0\cdot\frac{\pi}{180}} S1(f)\cdot G1(f,\theta)\,d\theta \right) df}{mo} \qquad \Delta E19 = 0.0148$$

$$H19 := 4\cdot\sqrt{mo\cdot\Delta E19} \qquad H19 = 0.1212$$

$$\theta 19 := -5$$

*the distribution is symmetric with respect to θ, therefore the remaining nine direction bands will follow the same trend with heights equivalent to that of the equal but opposite angles. see the example below for $\theta = 5$ which has the same height and relative energy as $\theta = -5$

$$\Delta E110 := \frac{\displaystyle\int_{fmin}^{0.1271} \left(\int_{0\cdot\frac{\pi}{180}}^{10\cdot\frac{\pi}{180}} S1(f)\cdot G1(f,\theta)\,d\theta \right) df}{mo} \qquad \Delta E110 = 0.0148$$

$$H110 := 4\cdot\sqrt{mo\cdot\Delta E110} \quad H110 = 0.1212$$

$$\theta 110 := 5$$

Similar calculations were carried out for the remaining nine frequency bands. The only difference is with respect to the spreading function used, where the definitions depend on whether the representative frequency is less than or greater than the peak frequency.

APPENDIX E:

Nearshore wave conditions for one-dimensional spectral components

Table E.1. Nearshore wave conditions for 1-D spectral components from RCPWAVE ($T_p = 7$ s)

		1-D NEARSHORE WAVE CHARACTERISTICS (T_p = 7s)							
FREQUENCY BANDS		Site A		Site B		Site C		Site D	
Band	T_i [s]	H_i [m]	Θ_i [°]	H_i [m]	Θ_i [°]	H_i [m]	Θ_i [°]	H_i [m]	Θ_i [°]
1	8.5413	0.2678	20.7752	0.2466	24.0648	0.2499	18.3638	0.2506	20.8132
2	7.5807	0.2655	17.5804	0.2452	20.8897	0.2485	15.6929	0.2501	18.1299
3	7.2245	0.2654	16.1971	0.2458	19.4722	0.2488	14.5043	0.2507	16.9219
4	6.9834	0.2658	15.1845	0.2466	18.4244	0.2495	13.6309	0.2514	16.0298
5	6.7583	0.2665	14.1785	0.2478	17.3759	0.2504	12.7596	0.2523	15.1340
6	6.5001	0.2677	12.9694	0.2496	16.0922	0.2520	11.6989	0.2538	14.0367
7	6.1304	0.2699	11.1449	0.2532	14.1066	0.2553	10.0765	0.2568	12.3295
8	5.5518	0.2761	8.0658	0.2619	10.6559	0.2633	7.3354	0.2640	9.3515
9	4.7819	0.2889	4.0058	0.2796	5.7894	0.2802	3.7046	0.2793	5.1159
10	3.4995	0.3117	0.2766	0.3105	0.5560	0.3103	0.3155	0.3094	0.5343
	Θ_{mean} [°]		***12.0378***		***14.7427***		***10.8082***		***12.8397***

Table E.2. Combined shoaling/refraction coefficients for 1-D spectral components ($T_p = 7$ s)

		1-D Component Transformation Coefficients (T_p = 7s)			
FREQUENCY BANDS		Site A	Site B	Site C	Site D
Band	T_i [s]	$(K_sK_r)_i$	$(K_sK_r)_i$	$(K_sK_r)_i$	$(K_sK_r)_i$
1	8.5413	0.8518	0.7844	0.7948	0.7971
2	7.5807	0.8445	0.7799	0.7904	0.7955
3	7.2245	0.8441	0.7818	0.7913	0.7974
4	6.9834	0.8454	0.7844	0.7936	0.7996
5	6.7583	0.8476	0.7882	0.7964	0.8025
6	6.5001	0.8515	0.7939	0.8015	0.8073
7	6.1304	0.8585	0.8053	0.8120	0.8168
8	5.5518	0.8782	0.8330	0.8375	0.8397
9	4.7819	0.9189	0.8893	0.8912	0.8884
10	3.4995	0.9914	0.9876	0.9870	0.9841
	$(K_sK_r)_{eff}$	***0.8744***	***0.8252***	***0.8318***	***0.8348***

Table E.3. Nearshore wave conditions for 1-D spectral components from RCPWAVE (T_p = 10 s)

		1-D NEARSHORE WAVE CHARACTERISTICS (T_p = 10s)							
FREQUENCY BANDS		Site A		Site B		Site C		Site D	
Band	T_i [s]	H_i [m]	Θ_i [°]	H_i [m]	Θ_i [°]	H_i [m]	Θ_i [°]	H_i [m]	Θ_i [°]
1	12.1982	0.2905	27.4424	0.2661	30.4227	0.2657	23.7058	0.2617	26.0390
2	10.8275	0.2809	25.7092	0.2578	28.7936	0.2590	22.3468	0.2565	24.7285
3	10.3162	0.2775	24.8625	0.2549	27.9945	0.2567	21.6765	0.2549	24.0779
4	9.9704	0.2753	24.2228	0.2529	27.3847	0.2551	21.1631	0.2538	23.5769
5	9.6488	0.2733	23.5603	0.2513	26.7541	0.2539	20.6322	0.2529	23.0571
6	9.2790	0.2712	22.7269	0.2494	25.9550	0.2524	19.9586	0.2520	22.3939
7	8.7507	0.2687	21.3650	0.2473	24.6405	0.2506	18.8492	0.2509	21.2959
8	7.9220	0.2659	18.8159	0.2453	22.1280	0.2487	16.7314	0.2500	19.1771
9	6.8190	0.2663	14.4490	0.2475	17.6627	0.2502	12.9977	0.2521	15.3797
10	4.9906	0.2850	5.0510	0.2742	7.0866	0.2750	4.6380	0.2744	6.2484
	Θ_{mean} [°]		***20.8205***		***23.8822***		***18.2699***		***20.5974***

Table E.4. Combined shoaling/refraction coefficients for 1-D spectral components (T_p = 10 s)

		1-D Component Transformation Coefficients (T_p = 10s)			
FREQUENCY BANDS		Site A	Site B	Site C	Site D
Band	T_i [s]	$(K_sK_r)_i$	$(K_sK_r)_i$	$(K_sK_r)_i$	$(K_sK_r)_i$
1	12.1982	0.9240	0.8464	0.8451	0.8324
2	10.8275	0.8934	0.8200	0.8238	0.8158
3	10.3162	0.8826	0.8108	0.8165	0.8108
4	9.9704	0.8756	0.8044	0.8114	0.8073
5	9.6488	0.8693	0.7993	0.8076	0.8044
6	9.2790	0.8626	0.7933	0.8028	0.8015
7	8.7507	0.8546	0.7866	0.7971	0.7980
8	7.9220	0.8457	0.7802	0.7910	0.7952
9	6.8190	0.8470	0.7872	0.7958	0.8018
10	4.9906	0.9065	0.8721	0.8747	0.8728
	$(K_sK_r)_{eff}$	***0.8765***	***0.8105***	***0.8169***	***0.8143***

APPENDIX F:

Nearshore wave conditions for two-dimensional spectral components using cosine-squared spreading function (*note: highlighted cells denote neglected components*)

Table F.1. Nearshore wave conditions at Site A for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0079	-29.5960
2	-75	0.0237	-10.3852	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0154	-22.9352
3	-65	0.0289	-10.4403	0.0196	-19.1538	0.0559	-18.5167	[illegible]	[illegible]	0.0433	-29.1774
4	-55	0.0465	-7.8358	0.0469	-14.7881	0.0468	-17.7880	0.0471	-19.9574	0.0473	-22.0762
5	-45	0.0602	-2.9550	0.0605	-9.2101	0.0604	-11.9276	0.0607	-13.8990	0.0608	-15.8291
6	-35	0.0712	2.2128	0.0712	-3.3069	0.0709	-5.7194	0.0713	-7.4775	0.0715	-9.2093
7	-25	0.0794	7.4608	0.0791	2.6193	0.0788	0.4881	0.0792	-1.0499	0.0794	-2.5707
8	-15	0.0849	12.7188	0.0846	8.5240	0.0843	6.6931	0.0847	5.3594	0.0850	4.0531
9	-5	0.0883	18.0527	0.0881	14.5182	0.0877	12.9921	0.0879	11.8698	0.0884	10.7566
10	5	0.0897	23.5473	0.0893	20.6937	0.0888	19.4525	0.0890	18.5412	0.0894	17.6483
11	15	0.0889	29.2751	0.0881	27.1039	0.0876	26.1434	0.0878	25.4385	0.0879	24.7477
12	25	0.0851	35.2655	0.0843	33.7862	0.0837	33.0985	0.0839	32.5957	0.0839	32.0938
13	35	0.0778	41.4759	0.0773	40.7197	0.0767	40.3207	0.0769	40.0091	0.0769	39.6916
14	45	0.0673	47.7000	0.0673	47.7779	0.0669	47.6825	0.0671	47.5782	0.0670	47.4609
15	55	0.0532	53.6599	0.0540	54.8280	0.0540	55.0210	0.0542	55.1447	0.0543	55.2417
16	65	0.0496	55.5029	0.0441	57.0888	0.0441	57.8186	0.0435	56.9070	0.0457	57.2516
17	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-75	0.0154	-26.7838	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	-65	0.0334	-28.9596	0.0370	-32.5449	0.0313	-40.3198	0.0388	-47.7001	0.0355	-70.8624
4	-55	0.0475	-24.6229	0.0479	-28.4712	0.0488	-34.9043	0.0516	-43.7128	0.0594	-53.6938
5	-45	0.0610	-18.1553	0.0615	-21.6790	0.0626	-27.5734	0.0655	-35.5473	0.0731	-43.9635
6	-35	0.0717	-11.2916	0.0724	-14.4618	0.0737	-19.7770	0.0771	-26.9352	0.0849	-34.2569
7	-25	0.0798	-4.4010	0.0804	-7.1965	0.0820	-11.9149	0.0860	-18.2217	0.0941	-24.4424
8	-15	0.0854	2.4637	0.0862	0.0433	0.0880	-4.0177	0.0925	-9.4635	0.1005	-14.5684
9	-5	0.0888	9.4193	0.0896	7.4041	0.0917	3.9911	0.0959	-0.5169	0.1037	-4.6927
10	5	0.0897	16.5655	0.0904	14.9289	0.0924	12.1785	0.0964	8.5562	0.1037	5.2490
11	15	0.0882	23.9124	0.0887	22.6407	0.0901	20.5138	0.0939	17.7310	0.1007	15.2152
12	25	0.0839	31.4859	0.0843	30.5560	0.0853	29.0026	0.0884	26.9801	0.0945	25.1658
13	35	0.0769	39.3040	0.0771	38.6976	0.0778	37.6684	0.0805	36.3212	0.0855	35.1201
14	45	0.0670	47.2938	0.0672	47.0223	0.0677	46.4872	0.0696	45.7813	0.0739	45.0809
15	55	0.0545	55.3184	0.0546	55.4529	0.0552	55.4872	0.0567	55.2430	0.0600	55.0303
16	65	0.0480	57.4176	0.0411	57.8228	0.0456	57.9392	0.0446	56.3681	0.0365	56.1387
17	75	0.0495	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	85	4.3600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F.1. Nearshore wave conditions at Site A for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**5.4635**	**-16.3251**	**5.2387**	**-21.4025**	**2.1783**	**-12.0250**	**4.6180**	**-25.2144**	0.0079	-29.5960
2	-75	0.0237	-10.3852	**4.2019**	**-22.1813**	**4.2480**	**-22.0231**	**4.0456**	**-27.0464**	0.0154	-22.9352
3	-65	0.0289	-10.4403	0.0196	-19.1538	0.0559	-18.5167	**4.1622**	**-27.7969**	0.0433	-29.1774
4	-55	0.0465	-7.8358	0.0469	-14.7881	0.0468	-17.7880	0.0471	-19.9574	0.0473	-22.0762
5	-45	0.0602	-2.9550	0.0605	-9.2101	0.0604	-11.9276	0.0607	-13.8990	0.0608	-15.8291
6	-35	0.0712	2.2128	0.0712	-3.3069	0.0709	-5.7194	0.0713	-7.4775	0.0715	-9.2093
7	-25	0.0794	7.4608	0.0791	2.6193	0.0788	0.4881	0.0792	-1.0499	0.0794	-2.5707
8	-15	0.0849	12.7188	0.0846	8.5240	0.0843	6.6931	0.0847	5.3594	0.0850	4.0531
9	-5	0.0883	18.0527	0.0881	14.5182	0.0877	12.9921	0.0879	11.8698	0.0884	10.7566
10	5	0.0897	23.5473	0.0893	20.6937	0.0888	19.4525	0.0890	18.5412	0.0894	17.6483
11	15	0.0889	29.2751	0.0881	27.1039	0.0876	26.1434	0.0878	25.4385	0.0879	24.7477
12	25	0.0851	35.2655	0.0843	33.7862	0.0837	33.0985	0.0839	32.5957	0.0839	32.0938
13	35	0.0778	41.4759	0.0773	40.7197	0.0767	40.3207	0.0769	40.0091	0.0769	39.6916
14	45	0.0673	47.7000	0.0673	47.7779	0.0669	47.6825	0.0671	47.5782	0.0670	47.4609
15	55	0.0532	53.6599	0.0540	54.8280	0.0540	55.0210	0.0542	55.1447	0.0543	55.2417
16	65	0.0496	55.5029	0.0441	57.0888	0.0441	57.8186	0.0435	56.9070	0.0457	57.2516
17	75	**4.0000**	**56.5147**	**4.6122**	**57.0414**	**6.2553**	**57.7032**	**4.5359**	**58.2886**	**0.0396**	**57.3395**
18	85	**4.0000**	**56.8152**	**4.0000**	**56.5684**	**4.0000**	**57.0253**	**5.2964**	**57.3264**	**5.5349**	**57.6778**

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**4.1136**	**-31.6437**	**3.9447**	**-36.4056**	**2.8240**	**-44.4975**	**0.4227**	**-52.0916**	**2.6110**	**-38.6207**
2	-75	0.0154	-26.7838	**0.6831**	**-37.0455**	**3.7133**	**-41.6178**	**0.0514**	**-50.9684**	**0.0880**	**-37.8928**
3	-65	0.0334	-28.9596	0.0370	-32.5449	0.0313	-40.3198	0.0388	-47.7001	0.0355	-70.8624
4	-55	0.0475	-24.6229	0.0479	-28.4712	0.0488	-34.9043	0.0516	-43.7128	0.0594	-53.6938
5	-45	0.0610	-18.1553	0.0615	-21.6790	0.0626	-27.5734	0.0655	-35.5473	0.0731	-43.9635
6	-35	0.0717	-11.2916	0.0724	-14.4618	0.0737	-19.7770	0.0771	-26.9352	0.0849	-34.2569
7	-25	0.0798	-4.4010	0.0804	-7.1965	0.0820	-11.9149	0.0860	-18.2217	0.0941	-24.4424
8	-15	0.0854	2.4637	0.0862	0.0433	0.0880	-4.0177	0.0925	-9.4635	0.1005	-14.5684
9	-5	0.0888	9.4193	0.0896	7.4041	0.0917	3.9911	0.0959	-0.5169	0.1037	-4.6927
10	5	0.0897	16.5655	0.0904	14.9289	0.0924	12.1785	0.0964	8.5562	0.1037	5.2490
11	15	0.0882	23.9124	0.0887	22.6407	0.0901	20.5138	0.0939	17.7310	0.1007	15.2152
12	25	0.0839	31.4859	0.0843	30.5560	0.0853	29.0026	0.0884	26.9801	0.0945	25.1658
13	35	0.0769	39.3040	0.0771	38.6976	0.0778	37.6684	0.0805	36.3212	0.0855	35.1201
14	45	0.0670	47.2938	0.0672	47.0223	0.0677	46.4872	0.0696	45.7813	0.0739	45.0809
15	55	0.0545	55.3184	0.0546	55.4529	0.0552	55.4872	0.0567	55.2430	0.0600	55.0303
16	65	0.0480	57.4176	0.0411	57.8228	0.0456	57.9392	0.0446	56.3681	0.0365	56.1387
17	75	0.0495	57.4866	0.0610	58.2685	1.0746	57.8511	0.0701	53.4400	0.1402	64.5561
18	85	4.3600	57.1377	1.3696	58.6509	1.1677	58.5212	5.5692	57.6575	0.3582	55.8240

Table F.2. Nearshore wave conditions at Site A for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0036	-4.7231	[illegible]	[illegible]
2	-75	0.0062	4.1548	[illegible]	[illegible]	[illegible]	[illegible]	0.0039	-3.1891	[illegible]	[illegible]
3	-65	0.0313	5.1234	0.0301	1.0492	0.0292	-0.6816	0.0449	-2.1722	0.0279	-3.9260
4	-55	0.0476	7.1160	0.0470	3.3747	0.0471	1.3739	0.0466	-0.1177	0.0468	-1.6267
5	-45	0.0630	10.7807	0.0617	6.9754	0.0616	5.2187	0.0607	3.9007	0.0609	2.5710
6	-35	0.0763	14.1919	0.0742	10.8870	0.0738	9.3600	0.0726	8.2132	0.0726	7.0521
7	-25	0.0867	17.8854	0.0836	15.0318	0.0829	13.7022	0.0814	12.7054	0.0812	11.6934
8	-15	0.0931	21.7114	0.0897	19.2807	0.0890	18.1391	0.0873	17.2718	0.0871	16.3913
9	-5	0.0962	25.5332	0.0930	23.5553	0.0924	22.6078	0.0907	21.8831	0.0905	21.1483
10	5	0.0972	29.3675	0.0943	27.8904	0.0938	27.1603	0.0921	26.5954	0.0920	26.0180
11	15	0.0956	33.3019	0.0931	32.3797	0.0927	31.8887	0.0912	31.4952	0.0911	31.0843
12	25	0.0903	37.3382	0.0885	37.0300	0.0883	36.8020	0.0870	36.6042	0.0870	36.3813
13	35	0.0809	41.3627	0.0799	41.7361	0.0800	41.8104	0.0789	41.8289	0.0791	41.8151
14	45	0.0672	45.1052	0.0671	46.2073	0.0675	46.6216	0.0669	46.8912	0.0675	47.1180
15	55	0.0507	48.3099	0.0510	50.2138	0.0517	51.0157	0.0515	51.5022	0.0521	51.9921
16	65	0.0332	51.0273	0.0350	52.1888	0.0352	52.3154	[illegible]	[illegible]	[illegible]	[illegible]
17	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	-65	0.0348	-6.5212	0.0423	-7.5020	0.0441	-13.7969	0.0381	-26.4655	0.0438	-45.9810
4	-55	0.0465	-3.5127	0.0466	-6.5288	0.0468	-12.1316	0.0471	-21.4948	0.0506	-41.3646
5	-45	0.0604	0.8987	0.0603	-1.7849	0.0603	-6.8117	0.0607	-15.2982	0.0645	-33.4490
6	-35	0.0717	5.5911	0.0714	3.2399	0.0712	-1.1869	0.0714	-8.7358	0.0758	-25.0639
7	-25	0.0802	10.4203	0.0796	8.3563	0.0791	4.4739	0.0783	-2.1572	0.0847	-16.5947
8	-15	0.0858	15.2881	0.0852	13.5013	0.0846	10.1416	0.0847	4.4184	0.0910	-8.2063
9	-5	0.0894	20.2180	0.0887	18.7125	0.0880	15.8880	0.0882	11.0633	0.0945	0.6555
10	5	0.0909	25.2798	0.0901	24.0781	0.0893	21.7961	0.0893	17.8924	0.0950	9.4895
11	15	0.0900	30.5583	0.0892	29.6714	0.0883	27.9463	0.0878	24.9374	0.0926	18.4418
12	25	0.0860	36.0725	0.0854	35.5185	0.0845	34.3714	0.0838	32.2307	0.0873	27.4985
13	35	0.0784	41.7572	0.0780	41.5799	0.0775	41.0416	0.0768	39.7784	0.0794	36.6686
14	45	0.0672	47.3486	0.0674	47.6216	0.0674	47.8007	0.0670	47.4958	0.0688	45.9642
15	55	0.0523	52.4895	0.0530	53.3473	0.0537	54.4972	0.0542	55.2214	0.0561	55.2663
16	65	0.0484	54.8137	0.0467	55.8405	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F.2. Nearshore wave conditions at Site A for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.5933	11.5724	2.9351	-0.2100	4.4911	-1.5641	0.0036	-4.7231	6.3487	-6.8991
2	-75	0.0062	4.1548	2.4050	1.3526	4.5064	-1.9075	0.0039	-3.1891	6.8002	-7.5161
3	-65	0.0313	5.1234	0.0301	1.0492	0.0292	-0.6816	0.0449	-2.1722	0.0279	-3.9260
4	-55	0.0476	7.1160	0.0470	3.3747	0.0471	1.3739	0.0466	-0.1177	0.0468	-1.6267
5	-45	0.0630	10.7807	0.0617	6.9754	0.0616	5.2187	0.0607	3.9007	0.0609	2.5710
6	-35	0.0763	14.1919	0.0742	10.8870	0.0738	9.3600	0.0726	8.2132	0.0726	7.0521
7	-25	0.0867	17.8854	0.0836	15.0318	0.0829	13.7022	0.0814	12.7054	0.0812	11.6934
8	-15	0.0931	21.7114	0.0897	19.2807	0.0890	18.1391	0.0873	17.2718	0.0871	16.3913
9	-5	0.0962	25.5332	0.0930	23.5553	0.0924	22.6078	0.0907	21.8831	0.0905	21.1483
10	5	0.0972	29.3675	0.0943	27.8904	0.0938	27.1603	0.0921	26.5954	0.0920	26.0180
11	15	0.0956	33.3019	0.0931	32.3797	0.0927	31.8887	0.0912	31.4952	0.0911	31.0843
12	25	0.0903	37.3382	0.0885	37.0300	0.0883	36.8020	0.0870	36.6042	0.0870	36.3813
13	35	0.0809	41.3627	0.0799	41.7361	0.0800	41.8104	0.0789	41.8289	0.0791	41.8151
14	45	0.0672	45.1052	0.0671	46.2073	0.0675	46.6216	0.0669	46.8912	0.0675	47.1180
15	55	0.0507	48.3099	0.0510	50.2138	0.0517	51.0157	0.0515	51.5022	0.0521	51.9921
16	65	0.0332	51.0273	0.0350	52.1888	0.0352	52.3154	0.4429	54.5228	0.0525	54.4437
17	75	4.0000	51.6190	4.0000	53.8388	4.0000	54.3180	4.0000	53.8128	4.0000	55.0663
18	85	4.0000	52.6834	4.0000	53.4068	7.0454	53.9308	0.0204	54.0960	6.3378	55.3907

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{o}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	6.8860	-11.0504	5.2036	-14.0498	4.5786	-20.2913	4.1169	-26.7834	3.1378	-51.1154
2	-75	6.1406	-6.3253	6.0702	-13.3040	5.0816	-19.2368	3.4022	-28.3681	0.0512	-51.0502
3	-65	0.0348	-6.5212	0.0423	-7.5020	0.0441	-13.7969	0.0381	-26.4655	0.0438	-45.9810
4	-55	0.0465	-3.5127	0.0466	-6.5288	0.0468	-12.1316	0.0471	-21.4948	0.0506	-41.3646
5	-45	0.0604	0.8987	0.0603	-1.7849	0.0603	-6.8117	0.0607	-15.2982	0.0645	-33.4490
6	-35	0.0717	5.5911	0.0714	3.2399	0.0712	-1.1869	0.0714	-8.7358	0.0758	-25.0639
7	-25	0.0802	10.4203	0.0796	8.3563	0.0791	4.4739	0.0783	-2.1572	0.0847	-16.5947
8	-15	0.0858	15.2881	0.0852	13.5013	0.0846	10.1416	0.0847	4.4184	0.0910	-8.2063
9	-5	0.0894	20.2180	0.0887	18.7125	0.0880	15.8880	0.0882	11.0633	0.0945	0.6555
10	5	0.0909	25.2798	0.0901	24.0781	0.0893	21.7961	0.0893	17.8924	0.0950	9.4895
11	15	0.0900	30.5583	0.0892	29.6714	0.0883	27.9463	0.0878	24.9374	0.0926	18.4418
12	25	0.0860	36.0725	0.0854	35.5185	0.0845	34.3714	0.0838	32.2307	0.0873	27.4985
13	35	0.0784	41.7572	0.0780	41.5799	0.0775	41.0416	0.0768	39.7784	0.0794	36.6686
14	45	0.0672	47.3486	0.0674	47.6216	0.0674	47.8007	0.0670	47.4958	0.0688	45.9642
15	55	0.0523	52.4895	0.0530	53.3473	0.0537	54.4972	0.0542	55.2214	0.0561	55.2663
16	65	0.0484	54.8137	0.0467	55.8405	0.0492	57.0656	0.0653	56.7130	0.0530	56.3161
17	75	4.0000	55.0663	4.0000	55.7600	4.4617	57.1657	4.9640	57.3134	0.0518	56.8662
18	85	6.3378	55.3907	5.8695	56.2983	4.0000	57.0585	4.9895	57.6422	3.6663	57.2768

Table F.3. Nearshore wave conditions at Site B for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-75	0.0206	1.7396	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0146	-12.6436
3	-65	0.0253	1.6946	0.0193	-7.2559	0.0514	-7.5728	[illegible]	-16.8662	0.0406	-18.5251
4	-55	0.0398	3.6404	0.0425	-3.6096	0.0433	-6.9521	0.0441	-9.4297	0.0446	-11.8904
5	-45	0.0498	7.0591	0.0528	0.7903	0.0538	-2.1233	0.0548	-4.2986	0.0556	-6.4771
6	-35	0.0581	10.4949	0.0606	5.1135	0.0614	2.6124	0.0626	0.7406	0.0635	-1.1446
7	-25	0.0658	13.9888	0.0671	9.3183	0.0678	7.1547	0.0688	5.5563	0.0696	3.9355
8	-15	0.0730	17.6941	0.0736	13.6262	0.0739	11.7814	0.0747	10.4105	0.0754	9.0438
9	-5	0.0795	21.8113	0.0796	18.3323	0.0795	16.7787	0.0800	15.6231	0.0807	14.4711
10	5	0.0842	26.4580	0.0839	23.5950	0.0836	22.3139	0.0840	21.3645	0.0844	20.4237
11	15	0.0859	31.6646	0.0854	29.4538	0.0849	28.4475	0.0852	27.7007	0.0854	26.9579
12	25	0.0837	37.3769	0.0832	35.8584	0.0827	35.1280	0.0829	34.5833	0.0829	34.0317
13	35	0.0774	43.4505	0.0771	42.6872	0.0766	42.2497	0.0767	41.9042	0.0767	41.5432
14	45	0.0664	49.6040	0.0670	49.7373	0.0668	49.6244	0.0670	49.4885	0.0670	49.3280
15	55	0.0516	55.3762	0.0531	56.4089	0.0534	56.7863	0.0538	56.9602	0.0541	57.0542
16	65	0.0442	56.9282	0.0408	58.5442	0.0432	59.0793	0.0467	58.7873	0.0419	59.2719
17	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0310	59.1123
18	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-75	0.0148	-16.8952	[illegible]	[illegible]	[illegible]	[illegible]	0.0350	-52.9201	[illegible]	[illegible]
3	-65	0.0342	-18.8045	0.0376	-23.1281	0.0313	-32.9333	0.0327	-41.7750	0.0305	-56.5682
4	-55	0.0452	-14.8869	0.0460	-19.4668	0.0470	-27.1764	0.0491	-37.8557	0.0574	-52.0029
5	-45	0.0565	-9.1541	0.0578	-13.3011	0.0597	-20.4057	0.0628	-30.3678	0.0717	-42.7292
6	-35	0.0646	-3.4674	0.0664	-7.1047	0.0691	-13.4381	0.0737	-22.4793	0.0839	-33.3541
7	-25	0.0709	1.9527	0.0726	-1.1643	0.0761	-6.6654	0.0821	-14.5712	0.0935	-23.8218
8	-15	0.0765	7.3548	0.0730	4.7118	0.0817	0.0715	0.0885	-6.6366	0.1000	-14.1307
9	-5	0.0815	13.0555	0.0829	10.8609	0.0863	7.0252	0.0924	1.5765	0.1033	-4.3698
10	5	0.0849	19.2674	0.0859	17.4823	0.0885	14.3958	0.0938	10.0755	0.1035	5.4910
11	15	0.0857	26.0471	0.0863	24.6369	0.0880	22.2144	0.0923	18.8674	0.1005	15.3861
12	25	0.0830	33.3530	0.0834	32.2930	0.0845	30.4572	0.0877	27.9204	0.0944	25.2980
13	35	0.0767	41.0853	0.0769	40.3475	0.0776	39.0371	0.0802	37.1831	0.0854	35.2283
14	45	0.0670	49.0926	0.0672	48.7029	0.0676	47.8796	0.0695	46.6193	0.0738	45.1811
15	55	0.0544	57.0764	0.0546	57.0271	0.0551	56.6231	0.0568	56.1724	0.0600	55.1455
16	65	0.0477	58.8377	0.0473	59.3194	0.0469	59.3502	0.0421	57.6615	0.0356	57.1416
17	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F.3. Nearshore wave conditions at Site B for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**5.4193**	**-2.9379**	**5.3508**	**-9.1007**	**2.0670**	**-2.5450**	**4.3987**	**-14.1781**	**0.0073**	**-18.891**
2	-75	0.0206	1.7396	**4.3784**	**-10.0668**	**4.0358**	**-10.7885**	**3.8087**	**-15.9241**	0.0146	-12.6436
3	-65	0.0253	1.6946	0.0193	-7.2559	0.0514	-7.5728	**3.6292**	-16.8662	0.0406	-18.5251
4	-55	0.0398	3.6404	0.0425	-3.6096	0.0433	-6.9521	0.0441	-9.4297	0.0446	-11.8904
5	-45	0.0498	7.0591	0.0528	0.7903	0.0538	-2.1233	0.0548	-4.2986	0.0556	-6.4771
6	-35	0.0581	10.4949	0.0606	5.1135	0.0614	2.6124	0.0626	0.7406	0.0635	-1.1446
7	-25	0.0658	13.9888	0.0671	9.3183	0.0678	7.1547	0.0688	5.5563	0.0696	3.9355
8	-15	0.0730	17.6941	0.0736	13.6262	0.0739	11.7814	0.0747	10.4105	0.0754	9.0438
9	-5	0.0795	21.8113	0.0796	18.3323	0.0795	16.7787	0.0800	15.6231	0.0807	14.4711
10	5	0.0842	26.4580	0.0839	23.5950	0.0836	22.3139	0.0840	21.3645	0.0844	20.4237
11	15	0.0859	31.6646	0.0854	29.4538	0.0849	28.4475	0.0852	27.7007	0.0854	26.9579
12	25	0.0837	37.3769	0.0832	35.8584	0.0827	35.1280	0.0829	34.5833	0.0829	34.0317
13	35	0.0774	43.4505	0.0771	42.6872	0.0766	42.2497	0.0767	41.9042	0.0767	41.5432
14	45	0.0664	49.6040	0.0670	49.7373	0.0668	49.6244	0.0670	49.4885	0.0670	49.3280
15	55	0.0516	55.3762	0.0531	56.4089	0.0534	56.7863	0.0538	56.9602	0.0541	57.0542
16	65	0.0442	56.9282	0.0408	58.5442	0.0432	59.0793	0.0467	58.7873	0.0419	59.2719
17	75	**4.0000**	**58.1080**	**6.7251**	**58.7578**	**4.0000**	**59.4234**	**6.7197**	**60.0780**	0.0310	59.1123
18	85	**4.0000**	**58.4907**	**4.5764**	**58.5961**	**4.5634**	**58.9312**	**4.0000**	**58.8527**	**5.7713**	**59.8012**

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**3.8993**	**-21.8982**	**3.9895**	**-27.4275**	**2.7099**	**-36.2956**	**0.3170**	**-46.5281**	**2.7674**	**-58.7953**
2	-75	0.0148	-16.8952	**0.6748**	**-28.1083**	**3.3824**	**-34.3764**	0.0350	-52.9201	**0.0585**	**-60.6608**
3	-65	0.0342	-18.8045	0.0376	-23.1281	0.0313	-32.9333	0.0327	-41.7750	0.0305	-56.5682
4	-55	0.0452	-14.8869	0.0460	-19.4668	0.0470	-27.1764	0.0491	-37.8557	0.0574	-52.0029
5	-45	0.0565	-9.1541	0.0578	-13.3011	0.0597	-20.4057	0.0628	-30.3678	0.0717	-42.7292
6	-35	0.0646	-3.4674	0.0664	-7.1047	0.0691	-13.4381	0.0737	-22.4793	0.0839	-33.3541
7	-25	0.0709	1.9527	0.0726	-1.1643	0.0761	-6.6654	0.0821	-14.5712	0.0935	-23.8218
8	-15	0.0765	7.3548	0.0730	4.7118	0.0817	0.0715	0.0885	-6.6366	0.1000	-14.1307
9	-5	0.0815	13.0555	0.0829	10.8609	0.0863	7.0252	0.0924	1.5765	0.1033	-4.3698
10	5	0.0849	19.2674	0.0859	17.4823	0.0885	14.3958	0.0938	10.0755	0.1035	5.4910
11	15	0.0857	26.0471	0.0863	24.6369	0.0880	22.2144	0.0923	18.8674	0.1005	15.3861
12	25	0.0830	33.3530	0.0834	32.2930	0.0845	30.4572	0.0877	27.9204	0.0944	25.2980
13	35	0.0767	41.0853	0.0769	40.3475	0.0776	39.0371	0.0802	37.1831	0.0854	35.2283
14	45	0.0670	49.0926	0.0672	48.7029	0.0676	47.8796	0.0695	46.6193	0.0738	45.1811
15	55	0.0544	57.0764	0.0546	57.0271	0.0551	56.6231	0.0568	56.1724	0.0600	55.1455
16	65	0.0477	58.8377	0.0473	59.3194	0.0469	59.3502	0.0421	57.6615	0.0356	57.1416
17	75	**0.0538**	**58.6311**	**0.0597**	**59.6329**	**2.0543**	**58.9486**	**0.0955**	**57.5315**	**0.0665**	**49.0257**
18	85	5.3295	58.9526	2.4544	60.1352	2.2454	59.0343	4.0000	58.9603	0.3401	60.3695

Table F.4. Nearshore wave conditions at Site B for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0034	7.7566	[redacted]	[redacted]
2	-75	0.0046	14.8490	[redacted]	[redacted]	[redacted]	[redacted]	0.0036	8.7504	[redacted]	[redacted]
3	-65	0.0237	15.3948	0.0236	12.1759	0.0232	10.6857	0.0362	9.4184	0.0229	7.9071
4	-55	0.0362	16.8641	0.0364	13.5627	0.0371	11.9519	0.0371	10.7081	0.0378	9.4108
5	-45	0.0486	18.6450	0.0477	15.6925	0.0480	14.2744	0.0477	13.1825	0.0483	12.0538
6	-35	0.0609	20.7424	0.0587	18.0716	0.0584	16.8055	0.0575	15.8377	0.0577	14.8424
7	-25	0.0719	23.1810	0.0687	20.7508	0.0680	19.6027	0.0667	18.7308	0.0665	17.8367
8	-15	0.0805	25.9017	0.0772	23.7327	0.0764	22.7017	0.0749	21.9144	0.0746	21.1108
9	-5	0.0868	28.8518	0.0838	27.0188	0.0832	26.1349	0.0816	25.4568	0.0814	24.7640
10	5	0.0907	32.0663	0.0882	30.6641	0.0878	29.9672	0.0863	29.4265	0.0862	28.8681
11	15	0.0913	35.5726	0.0894	34.6951	0.0891	34.2254	0.0878	33.8483	0.0878	33.4513
12	25	0.0878	39.3211	0.0865	39.0514	0.0864	38.8480	0.0852	38.6652	0.0853	38.4564
13	35	0.0790	43.1409	0.0785	43.5607	0.0787	43.6635	0.0778	43.7085	0.0782	43.7207
14	45	0.0653	46.6684	0.0654	47.8238	0.0659	48.2802	0.0654	48.5861	0.0660	48.8629
15	55	0.0490	49.7422	0.0493	51.4998	0.0500	52.2712	0.0498	52.8104	0.0504	53.3387
16	65	0.0322	52.1907	0.0334	53.6181	0.0323	53.6574	[redacted]	[redacted]	0.0442	56.1427
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	-75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
3	-65	0.0292	5.6716	0.0356	4.1899	0.0391	-2.1040	0.0359	-15.6631	0.0380	-39.9421
4	-55	0.0465	-3.5127	0.0394	4.9137	0.0415	-0.7501	0.0444	-11.2120	0.0483	-34.9730
5	-45	0.0484	10.5957	0.0494	8.1593	0.0517	3.2693	0.0553	-5.8744	0.0618	-27.6874
6	-35	0.0575	13.5631	0.0579	11.4456	0.0595	7.2358	0.0632	-0.6239	0.0722	-20.0386
7	-25	0.0658	16.6974	0.0656	14.8203	0.0664	11.1466	0.0693	4.3777	0.0802	-12.4525
8	-15	0.0736	20.0974	0.0731	18.4324	0.0732	15.2163	0.0750	9.4253	0.0864	-4.8047
9	-5	0.0804	23.8836	0.0798	22.4470	0.0794	19.6907	0.0805	14.7889	0.0905	3.0381
10	5	0.0852	28.1537	0.0845	26.9798	0.0839	24.7124	0.0842	20.6823	0.0921	11.2244
11	15	0.0868	32.9333	0.0862	32.0593	0.0855	30.3200	0.0852	27.1627	0.0909	19.7506
12	25	0.0845	38.1628	0.0840	37.6296	0.0834	36.4679	0.0828	34.1835	0.0866	28.5894
13	35	0.0776	43.6841	0.0775	43.5431	0.0772	43.0257	0.0766	41.6441	0.0792	37.6760
14	45	0.0659	49.1496	0.0664	49.4976	0.0669	49.7633	0.0669	49.3759	0.0688	46.9633
15	55	0.0506	54.0365	0.0514	55.0017	0.0525	56.1222	0.0540	57.0370	0.0561	56.3702
16	65	0.0441	56.6328	0.0435	57.4550	0.0470	58.7467	[redacted]	[redacted]	[redacted]	[redacted]
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table F.4. Nearshore wave conditions at Site B for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**0.6143**	**18.6366**	**2.6007**	**11.1070**	**6.5959**	**10.1326**	0.0034	7.7566	**6.5047**	**5.9576**
2	-75	0.0046	14.8490	**1.8479**	**12.3053**	**6.5271**	**9.9154**	0.0036	8.7504	**6.6626**	**5.4995**
3	-65	0.0237	15.3948	0.0236	12.1759	0.0232	10.6857	0.0362	9.4184	0.0229	7.9071
4	-55	0.0362	16.8641	0.0364	13.5627	0.0371	11.9519	0.0371	10.7081	0.0378	9.4108
5	-45	0.0486	18.6450	0.0477	15.6925	0.0480	14.2744	0.0477	13.1825	0.0483	12.0538
6	-35	0.0609	20.7424	0.0587	18.0716	0.0584	16.8055	0.0575	15.8377	0.0577	14.8424
7	-25	0.0719	23.1810	0.0687	20.7508	0.0680	19.6027	0.0667	18.7308	0.0665	17.8367
8	-15	0.0805	25.9017	0.0772	23.7327	0.0764	22.7017	0.0749	21.9144	0.0746	21.1108
9	-5	0.0868	28.8518	0.0838	27.0188	0.0832	26.1349	0.0816	25.4568	0.0814	24.7640
10	5	0.0907	32.0663	0.0882	30.6641	0.0878	29.9672	0.0863	29.4265	0.0862	28.8681
11	15	0.0913	35.5726	0.0894	34.6951	0.0891	34.2254	0.0878	33.8483	0.0878	33.4513
12	25	0.0878	39.3211	0.0865	39.0514	0.0864	38.8480	0.0852	38.6652	0.0853	38.4564
13	35	0.0790	43.1409	0.0785	43.5607	0.0787	43.6635	0.0778	43.7085	0.0782	43.7207
14	45	0.0653	46.6684	0.0654	47.8238	0.0659	48.2802	0.0654	48.5861	0.0660	48.8629
15	55	0.0490	49.7422	0.0493	51.4998	0.0500	52.2712	0.0498	52.8104	0.0504	53.3387
16	65	0.0322	52.1907	0.0334	53.6181	0.0323	53.6574	**0.9083**	**56.3093**	0.0442	56.1427
17	75	**4.6879**	**53.2399**	**4.0000**	**55.5827**	**4.0000**	**56.0468**	**4.6378**	**55.1962**	**4.0000**	**56.5449**
18	85	**4.0000**	**54.4617**	**4.0000**	**54.7528**	**4.0000**	**55.3544**	**0.0154**	**55.5946**	**4.0000**	**57.1454**

SITE B: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**5.5467**	**2.4504**	**5.1370**	**-0.7963**	**4.7893**	**-7.5881**	**4.1776**	**-16.1260**	**2.8345**	**-45.0744**
2	-75	**5.1220**	**5.8360**	**5.7102**	**-0.0472**	**5.0879**	**-6.5399**	**3.3009**	**-17.9793**	**0.0362**	**-47.3965**
3	-65	0.0292	5.6716	0.0356	4.1899	0.0391	-2.1040	0.0359	-15.6631	0.0380	-39.9421
4	-55	0.0465	-3.5127	0.0394	4.9137	0.0415	-0.7501	0.0444	-11.2120	0.0483	-34.9730
5	-45	0.0484	10.5957	0.0494	8.1593	0.0517	3.2693	0.0553	-5.8744	0.0618	-27.6874
6	-35	0.0575	13.5631	0.0579	11.4456	0.0595	7.2358	0.0632	-0.6239	0.0722	-20.0386
7	-25	0.0658	16.6974	0.0656	14.8203	0.0664	11.1466	0.0693	4.3777	0.0802	-12.4525
8	-15	0.0736	20.0974	0.0731	18.4324	0.0732	15.2163	0.0750	9.4253	0.0864	-4.8047
9	-5	0.0804	23.8836	0.0798	22.4470	0.0794	19.6907	0.0805	14.7889	0.0905	3.0381
10	5	0.0852	28.1537	0.0845	26.9798	0.0839	24.7124	0.0842	20.6823	0.0921	11.2244
11	15	0.0868	32.9333	0.0862	32.0593	0.0855	30.3200	0.0852	27.1627	0.0909	19.7506
12	25	0.0845	38.1628	0.0840	37.6296	0.0834	36.4679	0.0828	34.1835	0.0866	28.5894
13	35	0.0776	43.6841	0.0775	43.5431	0.0772	43.0257	0.0766	41.6441	0.0792	37.6760
14	45	0.0659	49.1496	0.0664	49.4976	0.0669	49.7633	0.0669	49.3759	0.0688	46.9633
15	55	0.0506	54.0365	0.0514	55.0017	0.0525	56.1222	0.0540	57.0370	0.0561	56.3702
16	65	0.0441	56.6328	0.0435	57.4550	0.0470	58.7467	**0.0676**	**58.1964**	**0.0500**	**58.1551**
17	75	**4.0000**	**57.2437**	**4.0000**	**57.4093**	**4.0000**	**58.9106**	**5.5429**	**59.5587**	**0.0553**	**59.0037**
18	85	0.0252	56.3971	**6.2348**	58.1654	4.0000	58.9688	**4.0000**	**59.1665**	**3.2911**	59.1382

Table F.5. Nearshore wave conditions at Site C for 2-D spectral components using cosine-squared spreading function from RCPWAVE ($T_p = 7$ s)

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0056	-10.615
2	-75	0.0123	2.5249	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0099	-8.0076
3	-65	0.0151	2.5045	0.0139	-2.6737	0.0320	-4.2395	[redacted]	[redacted]	0.0310	-10.2417
4	-55	0.0249	3.2263	0.0266	-1.4829	0.0277	-3.8137	0.0289	-5.6348	0.0301	-7.5371
5	-45	0.0348	4.7047	0.0355	0.3307	0.0363	-1.7699	0.0374	-3.3860	0.0385	-5.0582
6	-35	0.0459	6.5825	0.0459	2.4857	0.0461	0.5660	0.0469	-0.8854	0.0478	-2.3689
7	-25	0.0579	9.0064	0.0573	5.1833	0.0574	3.4253	0.0580	2.1214	0.0586	0.7968
8	-15	0.0696	12.1263	0.0691	8.6638	0.0690	7.1069	0.0694	5.9504	0.0699	4.8000
9	-5	0.0795	16.0747	0.0792	13.1064	0.0790	11.7868	0.0794	10.8118	0.0799	9.8443
10	5	0.0859	20.8437	0.0857	18.4986	0.0854	17.4494	0.0857	16.6753	0.0861	15.9091
11	15	0.0876	26.2762	0.0874	24.6513	0.0870	23.8961	0.0874	23.3354	0.0875	22.7768
12	25	0.0843	32.1292	0.0843	31.2932	0.0839	30.8517	0.0842	30.5096	0.0843	30.1594
13	35	0.0762	38.1155	0.0769	38.1639	0.0766	38.0589	0.0770	37.9445	0.0771	37.8067
14	45	0.0636	43.8722	0.0651	44.9778	0.0653	45.2719	0.0658	45.4148	0.0660	45.5229
15	55	0.0470	48.8453	0.0482	50.9147	0.0486	51.6833	0.0492	52.1149	0.0497	52.5077
16	65	0.0333	50.2697	0.0353	52.7326	0.0415	53.4865	0.0451	54.1059	0.0397	54.7964
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0231	54.3458
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, I =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	-75	0.0110	-10.9355	[redacted]	[redacted]	[redacted]	[redacted]	0.0298	-44.7373	[redacted]	[redacted]
3	-65	0.0293	-11.7292	0.0322	-15.9724	0.0272	-25.3595	0.0289	-36.3886	0.0309	-56.2982
4	-55	0.0317	-9.9875	0.0342	-14.0370	0.0382	-21.6640	0.0434	-33.4693	0.0547	-50.3541
5	-45	0.0400	-7.1934	0.0427	-10.6974	0.0476	-17.2978	0.0552	-27.6430	0.0693	-41.8016
6	-35	0.0490	-4.2385	0.0514	-7.2614	0.0563	-12.8632	0.0655	-21.5820	0.0823	-33.0104
7	-25	0.0596	-0.8403	0.0615	-3.4520	0.0661	-8.1769	0.0755	-15.2493	0.0926	-23.8462
8	-15	0.0708	3.3805	0.0724	1.1583	0.0763	-2.7288	0.0848	-8.2940	0.0996	-14.3176
9	-5	0.0805	8.6587	0.0818	6.8382	0.0849	3.7290	0.0914	-0.4811	0.1032	-4.5972
10	5	0.0865	14.9748	0.0874	13.5484	0.0816	11.5167	0.0944	8.0428	0.1035	5.2467
11	15	0.0879	22.0940	0.0884	21.0485	0.0899	19.2997	0.0935	17.0619	0.1006	15.1503
12	25	0.0845	29.7222	0.0849	29.0365	0.0859	27.8699	0.0887	26.3573	0.0944	25.0878
13	35	0.0772	37.6144	0.0775	37.2791	0.0783	36.6473	0.0807	35.7729	0.0854	35.0383
14	45	0.0663	45.5941	0.0668	45.6164	0.0675	45.5126	0.0695	45.2305	0.0738	44.9817
15	55	0.0503	52.9532	0.0512	53.4387	0.0524	53.9983	0.0552	54.4016	0.0598	54.8968
16	65	0.0452	54.7925	0.0444	55.5365	0.0465	56.0893	0.0388	56.0747	0.0350	56.5099
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table F.5. Nearshore wave conditions at Site C for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**4.1042**	**1.2869**	**3.9295**	**-3.0807**	**1.7277**	**-2.5333**	**3.3158**	**-7.4657**	0.0056	-10.615
2	-75	0.0123	2.5249	**3.6065**	**-3.4817**	**3.2161**	**-5.2790**	**3.3049**	**-8.2370**	0.0099	-8.0076
3	-65	0.0151	2.5045	0.0139	-2.6737	0.0320	-4.2395	**2.5341**	**-8.3548**	0.0310	-10.2417
4	-55	0.0249	3.2263	0.0266	-1.4829	0.0277	-3.8137	0.0289	-5.6348	0.0301	-7.5371
5	-45	0.0348	4.7047	0.0355	0.3307	0.0363	-1.7699	0.0374	-3.3860	0.0385	-5.0582
6	-35	0.0459	6.5825	0.0459	2.4857	0.0461	0.5660	0.0469	-0.8854	0.0478	-2.3689
7	-25	0.0579	9.0064	0.0573	5.1833	0.0574	3.4253	0.0580	2.1214	0.0586	0.7968
8	-15	0.0696	12.1263	0.0691	8.6638	0.0690	7.1069	0.0694	5.9504	0.0699	4.8000
9	-5	0.0795	16.0747	0.0792	13.1064	0.0790	11.7868	0.0794	10.8118	0.0799	9.8443
10	5	0.0859	20.8437	0.0857	18.4986	0.0854	17.4494	0.0857	16.6753	0.0861	15.9091
11	15	0.0876	26.2762	0.0874	24.6513	0.0870	23.8961	0.0874	23.3354	0.0875	22.7768
12	25	0.0843	32.1292	0.0843	31.2932	0.0839	30.8517	0.0842	30.5096	0.0843	30.1594
13	35	0.0762	38.1155	0.0769	38.1639	0.0766	38.0589	0.0770	37.9445	0.0771	37.8067
14	45	0.0636	43.8722	0.0651	44.9778	0.0653	45.2719	0.0658	45.4148	0.0660	45.5229
15	55	0.0470	48.8453	0.0482	50.9147	0.0486	51.6833	0.0492	52.1149	0.0497	52.5077
16	65	0.0333	50.2697	0.0353	52.7326	0.0415	53.4865	0.0451	54.1059	0.0397	54.7964
17	75	**4.0000**	**51.3593**	**6.3156**	**53.3509**	**6.8080**	**53.9871**	**6.6065**	**54.9252**	0.0231	54.3458
18	85	**4.0000**	**51.6575**	**4.1025**	**53.2058**	**4.0000**	**53.9505**	**6.6418**	**53.8134**	**6.1188**	**54.5970**

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	**3.3752**	**-13.0905**	**3.2630**	**-18.4791**	**2.9004**	**-27.7405**	**0.2749**	**-40.3808**	**2.4095**	**-56.2466**
2	-75	0.0110	-10.9355	**0.5361**	**-18.5509**	**2.9487**	**-26.3315**	0.0298	-44.7373	**0.3420**	**-56.0001**
3	-65	0.0293	-11.7292	0.0322	-15.9724	0.0272	-25.3595	0.0289	-36.3886	0.0309	-56.2982
4	-55	0.0317	-9.9875	0.0342	-14.0370	0.0382	-21.6640	0.0434	-33.4693	0.0547	-50.3541
5	-45	0.0400	-7.1934	0.0427	-10.6974	0.0476	-17.2978	0.0552	-27.6430	0.0693	-41.8016
6	-35	0.0490	-4.2385	0.0514	-7.2614	0.0563	-12.8632	0.0655	-21.5820	0.0823	-33.0104
7	-25	0.0596	-0.8403	0.0615	-3.4520	0.0661	-8.1769	0.0755	-15.2493	0.0926	-23.8462
8	-15	0.0708	3.3805	0.0724	1.1583	0.0763	-2.7288	0.0848	-8.2940	0.0996	-14.3176
9	-5	0.0805	8.6587	0.0818	6.8382	0.0849	3.7290	0.0914	-0.4811	0.1032	-4.5972
10	5	0.0865	14.9748	0.0874	13.5484	0.0816	11.5167	0.0944	8.0428	0.1035	5.2467
11	15	0.0879	22.0940	0.0884	21.0485	0.0899	19.2997	0.0935	17.0619	0.1006	15.1503
12	25	0.0845	29.7222	0.0849	29.0365	0.0859	27.8699	0.0887	26.3573	0.0944	25.0878
13	35	0.0772	37.6144	0.0775	37.2791	0.0783	36.6473	0.0807	35.7729	0.0854	35.0383
14	45	0.0663	45.5941	0.0668	45.6164	0.0675	45.5126	0.0695	45.2305	0.0738	44.9817
15	55	0.0503	52.9532	0.0512	53.4387	0.0524	53.9983	0.0552	54.4016	0.0598	54.8968
16	65	0.0452	54.7925	0.0444	55.5365	0.0465	56.0893	0.0388	56.0747	0.0350	56.5099
17	75	**0.0483**	**54.2141**	**0.0671**	**55.7216**	**3.1560**	**56.0165**	**0.0773**	**56.1483**	**0.0507**	**56.7329**
18	85	5.8111	55.2158	3.5186	56.1928	3.4063	56.1643	4.0000	56.7132	0.5436	59.4554

Table F.6. Nearshore wave conditions at Site C for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0032	6.5096	[redacted]	[redacted]
2	-75	0.0035	10.7524	[redacted]	[redacted]	[redacted]	[redacted]	0.0033	6.8635	[redacted]	[redacted]
3	-65	0.0178	11.0448	0.0163	8.9028	0.0155	7.9284	0.0236	7.1430	0.0146	6.2387
4	-55	0.0290	11.9222	0.0268	9.6051	0.0263	8.5273	0.0257	7.7111	0.0254	6.8757
5	-45	0.0418	13.1436	0.0386	10.8698	0.0377	9.8166	0.0366	9.0202	0.0363	8.2079
6	-35	0.0553	14.7739	0.0514	12.5523	0.0502	11.5237	0.0488	10.7472	0.0482	9.9576
7	-25	0.0679	16.8494	0.0639	14.7222	0.0627	13.7307	0.0611	12.9823	0.0605	12.2218
8	-15	0.0782	19.3152	0.0749	17.3930	0.0740	16.4820	0.0724	15.7889	0.0720	15.0852
9	-5	0.0862	22.1483	0.0836	20.5668	0.0831	19.8024	0.0816	19.2166	0.0815	18.6170
10	5	0.0909	25.3517	0.0890	24.2453	0.0888	23.6887	0.0874	23.2547	0.0875	22.8042
11	15	0.0914	28.8728	0.0899	28.3426	0.0899	28.0417	0.0887	27.7943	0.0889	27.5279
12	25	0.0866	32.5660	0.0857	32.6789	0.0858	32.6686	0.0848	32.6347	0.0851	32.5786
13	35	0.0759	36.1148	0.0757	36.9180	0.0762	37.2313	0.0755	37.4432	0.0760	37.6303
14	45	0.0617	39.2748	0.0619	40.7646	0.0625	41.4141	0.0620	41.8786	0.0627	42.3240
15	55	0.0463	42.0420	0.0463	44.1494	0.0467	45.0930	0.0463	45.7674	0.0466	46.4180
16	65	0.0303	44.3623	0.0304	46.1066	0.0292	46.2336	[redacted]	[redacted]	0.0344	49.0428
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	-75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
3	-65	0.0179	4.9923	0.0216	3.1763	0.0229	-0.1184	0.0281	-8.6169	0.0332	-33.8361
4	-55	0.0250	5.8067	0.0249	4.0296	0.0257	0.4175	0.0297	-7.0033	0.0420	-30.1925
5	-45	0.0355	7.1726	0.0350	5.4683	0.0350	2.0744	0.0382	-4.5905	0.0530	-24.7587
6	-35	0.0472	8.9529	0.0462	7.3144	0.0456	4.0999	0.0475	-1.9554	0.0627	-19.1537
7	-25	0.0593	11.2597	0.0582	9.6937	0.0573	6.6742	0.0583	1.1603	0.0726	-13.3189
8	-15	0.0708	14.2011	0.0699	12.7607	0.0690	10.0098	0.0697	5.1193	0.0821	-6.7907
9	-5	0.0805	17.8574	0.0798	16.6198	0.0792	14.2602	0.0797	10.1104	0.0894	0.6142
10	5	0.0866	22.2258	0.0861	21.2693	0.0857	19.4127	0.0859	16.1196	0.0930	8.8366
11	15	0.0880	27.1731	0.0877	26.5589	0.0874	25.2947	0.0874	22.9308	0.0923	17.6267
12	25	0.0845	32.4782	0.0844	32.2516	0.0843	31.6473	0.0842	30.2567	0.0877	26.7391
13	35	0.0758	37.8300	0.0761	38.0550	0.0670	31.1996	0.0770	37.8464	0.0797	35.9962
14	45	0.0628	42.8421	0.0635	43.5860	0.0646	44.6337	0.0659	45.4987	0.0688	45.3095
15	55	0.0465	47.1997	0.0469	48.3663	0.0476	50.1963	0.0495	52.4080	0.0543	54.3412
16	65	0.0359	49.6071	0.0373	50.6389	0.0412	52.5376	[redacted]	[redacted]	0.0477	56.4756
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table F.6. Nearshore wave conditions at Site C for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	$\Theta_{o,j}$[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.7090	12.7612	2.0745	8.2340	6.0352	7.6883	0.0032	6.5096	5.0466	5.6042
2	-75	0.0035	10.7524	1.3093	8.9133	5.9407	7.5973	0.0033	6.8635	5.0842	5.4315
3	-65	0.0178	11.0448	0.0163	8.9028	0.0155	7.9284	0.0236	7.1430	0.0146	6.2387
4	-55	0.0290	11.9222	0.0268	9.6051	0.0263	8.5273	0.0257	7.7111	0.0254	6.8757
5	-45	0.0418	13.1436	0.0386	10.8698	0.0377	9.8166	0.0366	9.0202	0.0363	8.2079
6	-35	0.0553	14.7739	0.0514	12.5523	0.0502	11.5237	0.0488	10.7472	0.0482	9.9576
7	-25	0.0679	16.8494	0.0639	14.7222	0.0627	13.7307	0.0611	12.9823	0.0605	12.2218
8	-15	0.0782	19.3152	0.0749	17.3930	0.0740	16.4820	0.0724	15.7889	0.0720	15.0852
9	-5	0.0862	22.1483	0.0836	20.5668	0.0831	19.8024	0.0816	19.2166	0.0815	18.6170
10	5	0.0909	25.3517	0.0890	24.2453	0.0888	23.6887	0.0874	23.2547	0.0875	22.8042
11	15	0.0914	28.8728	0.0899	28.3426	0.0899	28.0417	0.0887	27.7943	0.0889	27.5279
12	25	0.0866	32.5660	0.0857	32.6789	0.0858	32.6686	0.0848	32.6347	0.0851	32.5786
13	35	0.0759	36.1148	0.0757	36.9180	0.0762	37.2313	0.0755	37.4432	0.0760	37.6303
14	45	0.0617	39.2748	0.0619	40.7646	0.0625	41.4141	0.0620	41.8786	0.0627	42.3240
15	55	0.0463	42.0420	0.0463	44.1494	0.0467	45.0930	0.0463	45.7674	0.0466	46.4180
16	65	0.0303	44.3623	0.0304	46.1066	0.0292	46.2336	1.5336	49.1542	0.0344	49.0428
17	75	5.1412	45.8774	4.0000	48.2330	4.0000	48.8360	4.0000	47.9047	4.0000	49.2611
18	85	4.0000	46.7197	4.0000	47.0500	6.8036	47.6973	0.0112	48.2049	6.7592	49.7733

SITE C: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	$\Theta_{o,j}$[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.3415	4.0954	3.9479	2.3715	3.8773	-1.6025	3.7956	-8.8843	2.5468	-37.9382
2	-75	3.3060	5.0840	4.2200	2.5322	3.5419	-1.2705	2.2412	-9.7237	0.1014	-41.6549
3	-65	0.0179	4.9923	0.0216	3.1763	0.0229	-0.1184	0.0281	-8.6169	0.0332	-33.8361
4	-55	0.0250	5.8067	0.0249	4.0296	0.0257	0.4175	0.0297	-7.0033	0.0420	-30.1925
5	-45	0.0355	7.1726	0.0350	5.4683	0.0350	2.0744	0.0382	-4.5905	0.0530	-24.7587
6	-35	0.0472	8.9529	0.0462	7.3144	0.0456	4.0999	0.0475	-1.9554	0.0627	-19.1537
7	-25	0.0593	11.2597	0.0582	9.6937	0.0573	6.6742	0.0583	1.1603	0.0726	-13.3189
8	-15	0.0708	14.2011	0.0699	12.7607	0.0690	10.0098	0.0697	5.1193	0.0821	-6.7907
9	-5	0.0805	17.8574	0.0798	16.6198	0.0792	14.2602	0.0797	10.1104	0.0894	0.6142
10	5	0.0866	22.2258	0.0861	21.2693	0.0857	19.4127	0.0859	16.1196	0.0930	8.8366
11	15	0.0880	27.1731	0.0877	26.5589	0.0874	25.2947	0.0874	22.9308	0.0923	17.6267
12	25	0.0845	32.4782	0.0844	32.2516	0.0843	31.6473	0.0842	30.2567	0.0877	26.7391
13	35	0.0758	37.8300	0.0761	38.0550	0.0670	31.1996	0.0770	37.8464	0.0797	35.9962
14	45	0.0628	42.8421	0.0635	43.5860	0.0646	44.6337	0.0659	45.4987	0.0688	45.3095
15	55	0.0465	47.1997	0.0469	48.3663	0.0476	50.1963	0.0495	52.4080	0.0543	54.3412
16	65	0.0359	49.6071	0.0373	50.6389	0.0412	52.5376	0.0593	53.7822	0.0477	56.4756
17	75	6.4630	49.8762	7.3976	50.6299	7.0035	52.8117	6.2448	55.1530	0.0624	56.9794
18	85	0.0180	49.2672	7.6284	51.2992	4.0367	52.8428	4.8295	54.2619	1.9338	57.6712

Table F.7. Nearshore wave conditions at Site D for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0049	-5.5452
2	-75	0.0107	5.8592	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0084	-3.8202
3	-65	0.0131	5.8426	0.0122	1.2484	0.0264	-0.4288	[illegible]	[illegible]	0.0264	-5.2209
4	-55	0.0221	6.3949	0.0226	2.0266	0.0234	-0.0932	0.0243	-1.7407	0.0254	-3.4627
5	-45	0.0321	7.5994	0.0319	3.4021	0.0322	1.4201	0.0329	-0.0937	0.0337	-1.6547
6	-35	0.0438	9.2444	0.0430	5.2022	0.0429	3.3304	0.0434	1.9239	0.0440	0.4923
7	-25	0.0567	11.5074	0.0557	7.6607	0.0556	5.9063	0.0560	4.6056	0.0563	3.2909
8	-15	0.0693	14.5553	0.0687	11.0422	0.0686	9.4640	0.0690	8.2935	0.0693	7.1273
9	-5	0.0796	18.5095	0.0796	15.5083	0.0795	14.1645	0.0798	13.1691	0.0803	12.1774
10	5	0.0860	23.3028	0.0862	20.9722	0.0860	19.9106	0.0863	19.1213	0.0867	18.3326
11	15	0.0874	28.7342	0.0876	27.1772	0.0874	26.4287	0.0878	25.8619	0.0880	25.2876
12	25	0.0839	34.5416	0.0844	33.8386	0.0842	33.4260	0.0845	33.0927	0.0847	32.7377
13	35	0.0752	40.4009	0.0765	40.6745	0.0765	40.6363	0.0770	40.5526	0.0772	40.4294
14	45	0.0612	45.8337	0.0627	47.7780	0.0631	47.5733	0.0638	47.7788	0.0643	47.9393
15	55	0.0428	50.2402	0.0433	52.3740	0.0435	53.1250	0.0439	53.6062	0.0444	54.0381
16	65	0.0261	51.5423	0.0302	53.8084	0.0385	54.6088	0.0409	55.4205	0.0374	55.9581
17	75	4.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0181	55.3234
18	85	4.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.0000	[illegible]

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-75	0.0095	-6.3656	[illegible]	[illegible]	[illegible]	[illegible]	0.0255	-39.8951	[illegible]	[illegible]
3	-65	0.0257	-6.8871	0.0286	-10.8564	0.0252	-19.8654	0.0261	-31.1989	0.0286	-53.1909
4	-55	0.0269	-5.6926	0.0296	-9.4333	0.0345	-16.7328	0.0405	-28.6399	0.0523	-47.7372
5	-45	0.0350	-3.6451	0.0374	-6.9259	0.0427	-13.2344	0.0510	-23.6263	0.0665	-39.9219
6	-35	0.0448	-1.3075	0.0469	-4.2183	0.0514	-9.6644	0.0607	-18.4814	0.0796	-31.7601
7	-25	0.0571	1.6671	0.0586	-0.9221	0.0626	-5.6418	0.0715	-12.9717	0.0907	-23.1179
8	-15	0.0700	5.6872	0.0714	3.4257	0.0747	-0.5892	0.0824	-6.5663	0.0985	-13.9136
9	-5	0.0808	10.9576	0.0820	9.0598	0.0846	5.7403	0.0905	0.9795	0.1027	-4.3412
10	5	0.0871	17.3615	0.0880	15.8468	0.0900	13.1997	0.0944	9.4370	0.1033	5.4440
11	15	0.0884	24.5715	0.0889	23.4373	0.0903	21.4115	0.0936	18.4657	0.1006	15.3351
12	25	0.0849	32.2753	0.0853	31.5083	0.0864	30.0540	0.0890	27.8010	0.0945	25.2815
13	35	0.0775	40.2323	0.0779	39.8362	0.0788	38.9295	0.0811	37.2924	0.0856	35.2552
14	45	0.0649	48.0489	0.0657	48.0807	0.0670	47.7854	0.0694	46.7959	0.0739	45.2095
15	55	0.0450	54.4760	0.0461	54.9664	0.0482	55.4510	0.0520	55.4702	0.0592	55.0163
16	65	0.0399	56.2330	0.0389	56.6998	0.0413	57.5078	0.0355	57.6384	0.0365	57.3258
17	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	85	4.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F.7. Nearshore wave conditions at Site D for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 7 s)

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	3.7121	5.0672	3.3032	0.9895	1.6260	0.7079	2.8667	-2.9617	0.0049	-5.5452
2	-75	0.0107	5.8592	3.1722	0.7611	2.8748	-1.0576	2.9578	-3.4374	0.0084	-3.8202
3	-65	0.0131	5.8426	0.0122	1.2484	0.0264	-0.4288	2.0354	-3.4706	0.0264	-5.2209
4	-55	0.0221	6.3949	0.0226	2.0266	0.0234	-0.0932	0.0243	-1.7407	0.0254	-3.4627
5	-45	0.0321	7.5994	0.0319	3.4021	0.0322	1.4201	0.0329	-0.0937	0.0337	-1.6547
6	-35	0.0438	9.2444	0.0430	5.2022	0.0429	3.3304	0.0434	1.9239	0.0440	0.4923
7	-25	0.0567	11.5074	0.0557	7.6607	0.0556	5.9063	0.0560	4.6056	0.0563	3.2909
8	-15	0.0693	14.5553	0.0687	11.0422	0.0686	9.4640	0.0690	8.2935	0.0693	7.1273
9	-5	0.0796	18.5095	0.0796	15.5083	0.0795	14.1645	0.0798	13.1691	0.0803	12.1774
10	5	0.0860	23.3028	0.0862	20.9722	0.0860	19.9106	0.0863	19.1213	0.0867	18.3326
11	15	0.0874	28.7342	0.0876	27.1772	0.0874	26.4287	0.0878	25.8619	0.0880	25.2876
12	25	0.0839	34.5416	0.0844	33.8386	0.0842	33.4260	0.0845	33.0927	0.0847	32.7377
13	35	0.0752	40.4009	0.0765	40.6745	0.0765	40.6363	0.0770	40.5526	0.0772	40.4294
14	45	0.0612	45.8337	0.0627	47.7780	0.0631	47.5733	0.0638	47.7788	0.0643	47.9393
15	55	0.0428	50.2402	0.0433	52.3740	0.0435	53.1250	0.0439	53.6062	0.0444	54.0381
16	65	0.0261	51.5423	0.0302	53.8084	0.0385	54.6088	0.0409	55.4205	0.0374	55.9581
17	75	4.0000	52.4738	5.9834	54.6321	4.3809	54.9928	6.5468	56.0038	0.0181	55.3234
18	85	4.0000	52.5861	4.0000	54.4822	4.0000	55.1417	6.9827	55.0120	4.0000	55.6604

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	3.1082	-7.8358	2.9375	-12.7844	2.7509	-21.7401	0.2420	-34.9181	2.0359	-58.0802
2	-75	0.0095	-6.3656	0.4763	-12.8249	2.7244	-20.6665	0.0255	-39.8951	0.6203	-60.8997
3	-65	0.0257	-6.8871	0.0286	-10.8564	0.0252	-19.8654	0.0261	-31.1989	0.0286	-53.1909
4	-55	0.0269	-5.6926	0.0296	-9.4333	0.0345	-16.7328	0.0405	-28.6399	0.0523	-47.7372
5	-45	0.0350	-3.6451	0.0374	-6.9259	0.0427	-13.2344	0.0510	-23.6263	0.0665	-39.9219
6	-35	0.0448	-1.3075	0.0469	-4.2183	0.0514	-9.6644	0.0607	-18.4814	0.0796	-31.7601
7	-25	0.0571	1.6671	0.0586	-0.9221	0.0626	-5.6418	0.0715	-12.9717	0.0907	-23.1179
8	-15	0.0700	5.6872	0.0714	3.4257	0.0747	-0.5892	0.0824	-6.5663	0.0985	-13.9136
9	-5	0.0808	10.9576	0.0820	9.0598	0.0846	5.7403	0.0905	0.9795	0.1027	-4.3412
10	5	0.0871	17.3615	0.0880	15.8468	0.0900	13.1997	0.0944	9.4370	0.1033	5.4440
11	15	0.0884	24.5715	0.0889	23.4373	0.0903	21.4115	0.0936	18.4657	0.1006	15.3351
12	25	0.0849	32.2753	0.0853	31.5083	0.0864	30.0540	0.0890	27.8010	0.0945	25.2815
13	35	0.0775	40.2323	0.0779	39.8362	0.0788	38.9295	0.0811	37.2924	0.0856	35.2552
14	45	0.0649	48.0489	0.0657	48.0807	0.0670	47.7854	0.0694	46.7959	0.0739	45.2095
15	55	0.0450	54.4760	0.0461	54.9664	0.0482	55.4510	0.0520	55.4702	0.0592	55.0163
16	65	0.0399	56.2330	0.0389	56.6998	0.0413	57.5078	0.0355	57.6384	0.0365	57.3258
17	75	0.0378	55.6409	0.0703	56.9471	3.5944	57.2201	0.0666	57.6319	0.0674	57.5300
18	85	4.0000	56.4188	3.5991	57.6038	3.5841	57.6793	4.0000	57.2672	0.7887	57.3545

Table F.8. Nearshore wave conditions at Site D for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0032	9.7066	[redacted]	[redacted]
2	-75	0.0034	13.7490	[redacted]	[redacted]	[redacted]	[redacted]	0.0032	9.9835	[redacted]	[redacted]
3	-65	0.0168	14.0036	0.0151	11.9190	0.0143	10.9686	0.0214	10.2122	0.0132	9.3549
4	-55	0.0277	14.7881	0.0252	12.5265	0.0245	11.4791	0.0237	10.6876	0.0234	9.8799
5	-45	0.0405	15.9137	0.0370	13.6592	0.0359	12.6169	0.0347	11.8302	0.0343	11.0291
6	-35	0.0541	17.4538	0.0500	15.2217	0.0488	14.1880	0.0473	13.4080	0.0466	12.6156
7	-25	0.0666	19.4364	0.0628	17.2926	0.0617	16.2891	0.0601	15.5315	0.0595	14.7609
8	-15	0.0769	21.7972	0.0740	19.8800	0.0733	18.9643	0.0718	18.2659	0.0716	17.5553
9	-5	0.0848	24.5297	0.0828	22.9831	0.0825	22.2297	0.0812	21.6502	0.0812	21.0549
10	5	0.0896	27.6389	0.0881	26.5916	0.0881	26.0609	0.0869	25.6454	0.0871	25.2122
11	15	0.0901	31.0699	0.0889	30.6100	0.0891	30.3450	0.0880	30.1250	0.0883	29.8859
12	25	0.0846	34.6153	0.0840	34.8092	0.0844	34.8455	0.0836	34.8490	0.0841	34.8324
13	35	0.0736	37.9447	0.0737	38.8236	0.0744	39.1885	0.0738	39.4452	0.0744	39.6812
14	45	0.0603	40.9339	0.0603	42.4723	0.0608	43.1537	0.0602	43.6450	0.0608	44.1209
15	55	0.0453	43.5926	0.0447	45.6667	0.0446	46.5881	0.0439	47.2441	0.0439	47.8851
16	65	0.0294	45.8084	0.0284	47.5318	0.0276	47.6383	[redacted]	[redacted]	0.0296	50.2629
17	75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.0094	49.5790	[redacted]	[redacted]

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	-75	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
3	-65	0.0159	8.1968	0.0191	6.9000	0.0192	3.3714	0.0243	-4.0133	0.0303	-28.5523
4	-55	0.0228	8.8510	0.0223	7.1550	0.0222	3.7725	0.0250	-2.9791	0.0389	-25.2676
5	-45	0.0333	10.0107	0.0325	8.3427	0.0318	5.0628	0.0334	-1.2196	0.0487	-20.6580
6	-35	0.0455	11.6088	0.0443	9.9720	0.0431	6.7872	0.0438	0.8909	0.0578	-15.9661
7	-25	0.0582	13.7859	0.0571	12.2016	0.0559	9.1584	0.0562	3.6519	0.0686	-10.9205
8	-15	0.0704	16.6603	0.0696	15.1985	0.0688	12.4062	0.0691	7.4505	0.0799	-4.9186
9	-5	0.0804	20.2977	0.0799	19.0573	0.0795	16.6771	0.0801	12.4507	0.0886	2.2596
10	5	0.0864	24.6527	0.0861	23.7205	0.0860	21.8869	0.0866	18.5501	0.0930	10.4417
11	15	0.0876	29.5630	0.0875	28.9983	0.0875	27.8033	0.0878	25.4469	0.0925	19.2573
12	25	0.0837	34.7826	0.0839	34.6337	0.0842	34.1498	0.0846	32.8380	0.0880	28.4187
13	35	0.0744	39.9469	0.0750	40.2822	0.0760	40.6344	0.0770	40.4666	0.0802	37.7624
14	45	0.0607	44.6837	0.0612	45.5081	0.0622	46.7398	0.0641	47.9031	0.0686	47.1155
15	55	0.0433	48.6493	0.0430	49.7811	0.0430	51.6136	0.0442	53.9198	0.0509	55.5326
16	65	0.0311	50.7876	0.0321	51.7920	0.0362	53.4411	[redacted]	[redacted]	0.0432	57.5366
17	75	0.0143	50.9490	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18	85	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table F.8. Nearshore wave conditions at Site D for 2-D spectral components using cosine-squared spreading function from RCPWAVE (T_p = 10 s)

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.7775	15.4161	1.9804	11.3356	5.7595	10.7689	0.0032	9.7066	4.6116	8.8717
2	-75	0.0034	13.7490	1.2467	11.9124	5.6561	10.6938	0.0032	9.9835	4.6869	8.7410
3	-65	0.0168	14.0036	0.0151	11.9190	0.0143	10.9686	0.0214	10.2122	0.0132	9.3549
4	-55	0.0277	14.7881	0.0252	12.5265	0.0245	11.4791	0.0237	10.6876	0.0234	9.8799
5	-45	0.0405	15.9137	0.0370	13.6592	0.0359	12.6169	0.0347	11.8302	0.0343	11.0291
6	-35	0.0541	17.4538	0.0500	15.2217	0.0488	14.1880	0.0473	13.4080	0.0466	12.6156
7	-25	0.0666	19.4364	0.0628	17.2926	0.0617	16.2891	0.0601	15.5315	0.0595	14.7609
8	-15	0.0769	21.7972	0.0740	19.8800	0.0733	18.9643	0.0718	18.2659	0.0716	17.5553
9	-5	0.0848	24.5297	0.0828	22.9831	0.0825	22.2297	0.0812	21.6502	0.0812	21.0549
10	5	0.0896	27.6389	0.0881	26.5916	0.0881	26.0609	0.0869	25.6454	0.0871	25.2122
11	15	0.0901	31.0699	0.0889	30.6100	0.0891	30.3450	0.0880	30.1250	0.0883	29.8859
12	25	0.0846	34.6153	0.0840	34.8092	0.0844	34.8455	0.0836	34.8490	0.0841	34.8324
13	35	0.0736	37.9447	0.0737	38.8236	0.0744	39.1885	0.0738	39.4452	0.0744	39.6812
14	45	0.0603	40.9339	0.0603	42.4723	0.0608	43.1537	0.0602	43.6450	0.0608	44.1209
15	55	0.0453	43.5926	0.0447	45.6667	0.0446	46.5881	0.0439	47.2441	0.0439	47.8851
16	65	0.0294	45.8084	0.0284	47.5318	0.0276	47.6383	1.9534	50.3898	0.0296	50.2629
17	75	3.4999	47.4706	4.0000	49.5437	4.0000	50.1618	4.4151	49.2379	4.0000	50.5455
18	85	7.9270	48.1397	4.0000	48.4325	7.1119	48.8392	0.0094	49.5790	4.0001	51.0671

SITE D: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	3.8924	7.5632	3.5931	6.0054	3.3594	2.4666	3.3723	-4.1994	2.3628	-32.1767
2	-75	2.9779	8.2772	3.7357	6.0763	3.0515	2.6474	1.8287	-4.7742	0.2934	-37.3827
3	-65	0.0159	8.1968	0.0191	6.9000	0.0192	3.3714	0.0243	-4.0133	0.0303	-28.5523
4	-55	0.0228	8.8510	0.0223	7.1550	0.0222	3.7725	0.0250	-2.9791	0.0389	-25.2676
5	-45	0.0333	10.0107	0.0325	8.3427	0.0318	5.0628	0.0334	-1.2196	0.0487	-20.6580
6	-35	0.0455	11.6088	0.0443	9.9720	0.0431	6.7872	0.0438	0.8909	0.0578	-15.9661
7	-25	0.0582	13.7859	0.0571	12.2016	0.0559	9.1584	0.0562	3.6519	0.0686	-10.9205
8	-15	0.0704	16.6603	0.0696	15.1985	0.0688	12.4062	0.0691	7.4505	0.0799	-4.9186
9	-5	0.0804	20.2977	0.0799	19.0573	0.0795	16.6771	0.0801	12.4507	0.0886	2.2596
10	5	0.0864	24.6527	0.0861	23.7205	0.0860	21.8869	0.0866	18.5501	0.0930	10.4417
11	15	0.0876	29.5630	0.0875	28.9983	0.0875	27.8033	0.0878	25.4469	0.0925	19.2573
12	25	0.0837	34.7826	0.0839	34.6337	0.0842	34.1498	0.0846	32.8380	0.0880	28.4187
13	35	0.0744	39.9469	0.0750	40.2822	0.0760	40.6344	0.0770	40.4666	0.0802	37.7624
14	45	0.0607	44.6837	0.0612	45.5081	0.0622	46.7398	0.0641	47.9031	0.0686	47.1155
15	55	0.0433	48.6493	0.0430	49.7811	0.0430	51.6136	0.0442	53.9198	0.0509	55.5326
16	65	0.0311	50.7876	0.0321	51.7920	0.0362	53.4411	0.0500	55.1761	0.0432	57.5366
17	75	0.0143	50.9490	4.0001	51.7252	7.4109	53.8402	6.9989	56.3745	0.0604	58.3344
18	85	7.6328	50.5694	7.5918	52.3721	4.0000	53.9673	4.3522	55.6274	0.8576	59.0725

Table F.9. Combined shoaling/refraction coefficients at Site A for 2-D spectral components using cosine-squared spreading function (T_p = 7 s)

SITE A: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	520.0274	496.8091	207.4571	438.6873	0.7500
2	-75	0.8618	152.1952	154.5077	146.7826	0.5584
3	-65	0.6509	0.4398	1.2597	93.5602	0.9727
4	-55	0.7750	0.7780	0.7796	0.7826	0.7855
5	-45	0.8146	0.8151	0.8172	0.8192	0.8201
6	-35	0.8318	0.8286	0.8292	0.8312	0.8330
7	-25	0.8384	0.8323	0.8326	0.8348	0.8364
8	-15	0.8414	0.8360	0.8363	0.8378	0.8408
9	-5	0.8490	0.8439	0.8433	0.8436	0.8476
10	5	0.8625	0.8554	0.8538	0.8541	0.8572
11	15	0.8811	0.8706	0.8690	0.8684	0.8694
12	25	0.8986	0.8870	0.8844	0.8843	0.8838
13	35	0.9089	0.8996	0.8971	0.8965	0.8959
14	45	0.9107	0.9067	0.9051	0.9056	0.9037
15	55	0.8867	0.8957	0.8995	0.9006	0.9017
16	65	1.1171	0.9896	0.9938	0.9778	1.0267
17	75	145.4545	167.0565	227.5169	164.5717	1.4359
18	85	380.9524	379.3377	380.9524	503.1319	525.4601

SITE A: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	390.3887	374.4599	268.4578	40.1490	247.0640
2	-75	0.5582	24.7665	134.8209	1.8647	3.1804
3	-65	0.7501	0.8311	0.7050	0.8721	0.7960
4	-55	0.7885	0.7953	0.8114	0.8573	0.9832
5	-45	0.8232	0.8294	0.8454	0.8839	0.9827
6	-35	0.8357	0.8434	0.8598	0.8987	0.9859
7	-25	0.8409	0.8468	0.8649	0.9063	0.9880
8	-15	0.8439	0.8526	0.8713	0.9149	0.9901
9	-5	0.8515	0.8591	0.8800	0.9203	0.9914
10	5	0.8601	0.8668	0.8868	0.9251	0.9914
11	15	0.8715	0.8773	0.8921	0.9288	0.9921
12	25	0.8841	0.8879	0.8997	0.9316	0.9922
13	35	0.8963	0.8982	0.9076	0.9383	0.9929
14	45	0.9042	0.9063	0.9143	0.9392	0.9935
15	55	0.9047	0.9066	0.9179	0.9420	0.9931
16	65	1.0779	0.9232	1.0270	1.0024	0.8184
17	75	1.7943	2.2116	39.0161	2.5431	5.0670
18	85	413.7726	130.0125	111.0050	528.9758	83.8944
(KsKr)eff		*0.8746*				

Table F.10. Combined shoaling/refraction coefficients at Site A for 2-D spectral components using cosine-squared spreading function (T_p = 10 s)

SITE A: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	56.3757	278.4972	423.6887	0.3429	601.3005
2	-75	0.2255	87.1580	162.6859	0.1419	245.9945
3	-65	0.7038	0.6758	0.6518	1.0124	0.6253
4	-55	0.7911	0.7807	0.7771	0.7767	0.7761
5	-45	0.8505	0.8317	0.8255	0.8225	0.8195
6	-35	0.8903	0.8640	0.8542	0.8490	0.8438
7	-25	0.9146	0.8797	0.8677	0.8606	0.8538
8	-15	0.9218	0.8864	0.8743	0.8661	0.8590
9	-5	0.9232	0.8908	0.8800	0.8730	0.8660
10	5	0.9328	0.9033	0.8933	0.8864	0.8804
11	15	0.9465	0.9200	0.9106	0.9048	0.8984
12	25	0.9525	0.9312	0.9242	0.9199	0.9148
13	35	0.9440	0.9299	0.9259	0.9226	0.9194
14	45	0.9072	0.9040	0.9046	0.9065	0.9083
15	55	0.8427	0.8472	0.8530	0.8584	0.8640
16	65	0.7465	0.7858	0.7857	9.9867	1.1766
17	75	145.4545	144.8823	144.4043	145.5808	144.6984
18	85	380.0821	379.3377	664.6604	1.9429	600.2681

SITE A: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	655.8354	495.0679	434.8475	391.2423	298.2885
2	-75	223.3728	220.5725	184.3312	123.7164	1.8590
3	-65	0.7843	0.9523	0.9910	0.8568	0.9865
4	-55	0.7746	0.7755	0.7775	0.7837	0.8414
5	-45	0.8173	0.8150	0.8136	0.8203	0.8711
6	-35	0.8386	0.8341	0.8298	0.8327	0.8843
7	-25	0.8478	0.8403	0.8335	0.8256	0.8934
8	-15	0.8512	0.8444	0.8368	0.8386	0.9010
9	-5	0.8596	0.8521	0.8437	0.8464	0.9069
10	5	0.8740	0.8655	0.8562	0.8570	0.9117
11	15	0.8929	0.8840	0.8734	0.8693	0.9168
12	25	0.9091	0.9015	0.8904	0.8836	0.9208
13	35	0.9170	0.9112	0.9033	0.8957	0.9263
14	45	0.9093	0.9110	0.9094	0.9054	0.9292
15	55	0.8713	0.8820	0.8921	0.9018	0.9328
16	65	1.0908	1.0514	1.1056	1.4685	1.1937
17	75	145.5055	145.3478	161.8448	180.5091	1.8807
18	85	603.6238	558.4213	379.8956	474.1684	348.5293
(KrKs)eff		*0.8665*				

Table F.11. Combined shoaling/refraction coefficients at Site B for 2-D spectral components using cosine-squared spreading function ($T_p = 7$ s)

SITE B: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	515.8204	507.4401	196.8571	417.8548	0.6930
2	-75	0.7491	158.5881	146.7896	138.1874	0.5294
3	-65	0.5698	0.4331	1.1583	81.5791	0.9121
4	-55	0.6633	0.7050	0.7213	0.7328	0.7406
5	-45	0.6739	0.7114	0.7279	0.7396	0.7499
6	-35	0.6787	0.7052	0.7181	0.7298	0.7398
7	-25	0.6948	0.7060	0.7164	0.7252	0.7332
8	-15	0.7235	0.7273	0.7331	0.7389	0.7458
9	-5	0.7644	0.7625	0.7644	0.7678	0.7738
10	5	0.8096	0.8036	0.8038	0.8061	0.8093
11	15	0.8513	0.8439	0.8423	0.8427	0.8447
12	25	0.8838	0.8755	0.8738	0.8738	0.8733
13	35	0.9042	0.8973	0.8959	0.8941	0.8936
14	45	0.8985	0.9027	0.9038	0.9042	0.9037
15	55	0.8600	0.8808	0.8895	0.8939	0.8984
16	65	0.9955	0.9156	0.9735	1.0497	0.9413
17	75	145.4545	243.5869	145.4875	243.8044	1.1241
18	85	380.9524	434.0003	434.6095	379.9803	547.9030

SITE B: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	370.0513	378.7126	257.6111	30.1094	261.8633
2	-75	0.5365	24.4656	122.8067	1.2697	2.1143
3	-65	0.7680	0.8446	0.7050	0.7350	0.6839
4	-55	0.7503	0.7638	0.7815	0.8157	0.9501
5	-45	0.7625	0.7795	0.8063	0.8475	0.9639
6	-35	0.7529	0.7735	0.8061	0.8591	0.9743
7	-25	0.7471	0.7647	0.8027	0.8652	0.9817
8	-15	0.7559	0.7221	0.8089	0.8754	0.9852
9	-5	0.7815	0.7949	0.8282	0.8868	0.9876
10	5	0.8141	0.8236	0.8493	0.9002	0.9895
11	15	0.8468	0.8536	0.8713	0.9130	0.9901
12	25	0.8746	0.8784	0.8913	0.9243	0.9911
13	35	0.8939	0.8958	0.9053	0.9348	0.9917
14	45	0.9042	0.9063	0.9130	0.9379	0.9921
15	55	0.9030	0.9066	0.9162	0.9437	0.9931
16	65	1.0712	1.0625	1.0563	0.9463	0.7982
17	75	1.9501	2.1645	74.5866	3.4645	2.4034
18	85	505.7801	232.9897	213.4544	379.9294	32.1817
(KsKr)eff		*0.8330*				

Table F.12. Combined shoaling/refraction coefficients at Site B for 2-D spectral components using cosine-squared spreading function (T_p = 10 s)

SITE B: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	58.3711	246.7676	622.2547	0.3238	616.0756
2	-75	0.1673	66.9685	235.6354	0.1310	241.0169
3	-65	0.5329	0.5299	0.5179	0.8163	0.5132
4	-55	0.6017	0.6047	0.6121	0.6184	0.6269
5	-45	0.6561	0.6430	0.6433	0.6463	0.6499
6	-35	0.7106	0.6835	0.6759	0.6724	0.6706
7	-25	0.7584	0.7229	0.7117	0.7052	0.6993
8	-15	0.7970	0.7628	0.7505	0.7431	0.7357
9	-5	0.8330	0.8027	0.7924	0.7854	0.7789
10	5	0.8704	0.8448	0.8362	0.8306	0.8249
11	15	0.9040	0.8834	0.8752	0.8710	0.8659
12	25	0.9262	0.9102	0.9043	0.9008	0.8970
13	35	0.9218	0.9136	0.9109	0.9098	0.9089
14	45	0.8815	0.8811	0.8832	0.8862	0.8881
15	55	0.8144	0.8189	0.8250	0.8301	0.8358
16	65	0.7240	0.7499	0.7210	20.4808	0.9906
17	75	170.4691	144.8823	144.4043	168.7937	144.6984
18	85	380.0821	379.3377	377.3585	1.4667	378.8495

SITE B: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	528.2780	488.7316	454.8585	397.0109	269.4560
2	-75	186.3198	207.4912	184.5597	120.0327	1.3143
3	-65	0.6581	0.8015	0.8787	0.8073	0.8559
4	-55	0.7746	0.6557	0.6894	0.7388	0.8031
5	-45	0.6549	0.6677	0.6976	0.7473	0.8346
6	-35	0.6725	0.6764	0.6935	0.7371	0.8423
7	-25	0.6956	0.6925	0.6997	0.7307	0.8459
8	-15	0.7302	0.7245	0.7240	0.7426	0.8554
9	-5	0.7731	0.7666	0.7613	0.7726	0.8685
10	5	0.8192	0.8117	0.8044	0.8081	0.8839
11	15	0.8611	0.8543	0.8457	0.8436	0.9000
12	25	0.8932	0.8867	0.8789	0.8731	0.9134
13	35	0.9076	0.9054	0.8998	0.8933	0.9239
14	45	0.8917	0.8975	0.9027	0.9041	0.9292
15	55	0.8429	0.8554	0.8722	0.8985	0.9328
16	65	0.9939	0.9793	1.0562	1.5202	1.1261
17	75	145.5055	145.3478	145.0970	201.5600	2.0078
18	85	2.4001	593.1758	379.8956	380.1330	312.8617
(KrKs)eff		***0.7996***				

Table F.13. Combined shoaling/refraction coefficients at Site C for 2-D spectral components using cosine-squared spreading function ($T_p = 7$ s)

SITE C: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	390.6464	372.6519	164.5429	314.9847	0.5316
2	-75	0.4473	130.6295	116.9755	119.9085	0.3590
3	-65	0.3401	0.3119	0.7211	56.9629	0.6964
4	-55	0.4150	0.4412	0.4614	0.4802	0.4998
5	-45	0.4709	0.4783	0.4911	0.5048	0.5193
6	-35	0.5362	0.5342	0.5392	0.5467	0.5569
7	-25	0.6114	0.6029	0.6065	0.6113	0.6173
8	-15	0.6898	0.6828	0.6845	0.6864	0.6914
9	-5	0.7644	0.7586	0.7596	0.7620	0.7661
10	5	0.8260	0.8209	0.8212	0.8225	0.8256
11	15	0.8682	0.8636	0.8631	0.8645	0.8655
12	25	0.8902	0.8870	0.8865	0.8875	0.8880
13	35	0.8902	0.8949	0.8959	0.8976	0.8983
14	45	0.8606	0.8771	0.8835	0.8880	0.8902
15	55	0.7833	0.7995	0.8095	0.8175	0.8253
16	65	0.7500	0.7921	0.9352	1.0138	0.8919
17	75	145.4545	228.7546	247.6196	239.6973	0.8376
18	85	380.9524	389.0583	380.9524	630.9383	580.8931

SITE C: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	320.3131	309.7479	275.7206	26.1107	227.9972
2	-75	0.3987	19.4369	107.0601	1.0811	12.3604
3	-65	0.6580	0.7233	0.6126	0.6496	0.6928
4	-55	0.5262	0.5679	0.6352	0.7210	0.9054
5	-45	0.5398	0.5759	0.6429	0.7449	0.9316
6	-35	0.5711	0.5988	0.6568	0.7635	0.9557
7	-25	0.6280	0.6478	0.6972	0.7957	0.9722
8	-15	0.6996	0.7161	0.7554	0.8388	0.9813
9	-5	0.7719	0.7843	0.8148	0.8772	0.9866
10	5	0.8294	0.8380	0.7831	0.9060	0.9895
11	15	0.8686	0.8744	0.8901	0.9248	0.9911
12	25	0.8904	0.8942	0.9060	0.9348	0.9911
13	35	0.8998	0.9028	0.9134	0.9406	0.9917
14	45	0.8947	0.9009	0.9116	0.9379	0.9921
15	55	0.8350	0.8501	0.8713	0.9171	0.9898
16	65	1.0151	0.9973	1.0473	0.8721	0.7848
17	75	1.7508	2.4328	114.5867	2.8043	1.8324
18	85	551.4848	334.0113	323.8130	379.9294	51.4378
(KsKr)eff		*0.7946*				

Table F.14. Combined shoaling/refraction coefficients at Site C for 2-D spectral components using cosine-squared spreading function (T_p = 10 s)

SITE C: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	67.3695	196.8391	569.3585	0.3048	477.9755
2	-75	0.1273	47.4494	214.4657	0.1201	183.9189
3	-65	0.4002	0.3660	0.3460	0.5321	0.3272
4	-55	0.4820	0.4452	0.4339	0.4284	0.4212
5	-45	0.5643	0.5203	0.5052	0.4959	0.4885
6	-35	0.6453	0.5985	0.5810	0.5707	0.5602
7	-25	0.7162	0.6724	0.6562	0.6460	0.6362
8	-15	0.7743	0.7401	0.7269	0.7183	0.7101
9	-5	0.8273	0.8008	0.7914	0.7854	0.7799
10	5	0.8724	0.8525	0.8457	0.8412	0.8373
11	15	0.9050	0.8883	0.8831	0.8800	0.8767
12	25	0.9135	0.9018	0.8980	0.8966	0.8948
13	35	0.8856	0.8810	0.8819	0.8829	0.8833
14	45	0.8329	0.8340	0.8376	0.8401	0.8437
15	55	0.7695	0.7691	0.7705	0.7717	0.7728
16	65	0.6813	0.6826	0.6518	34.5804	0.7710
17	75	186.9527	144.8823	144.4043	145.5808	144.6984
18	85	380.0821	379.3377	641.8491	1.0667	640.1799

SITE C: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	413.4925	375.6012	3.8773	360.7082	242.1063
2	-75	120.2603	153.3419	3.5419	81.4982	3.6816
3	-65	0.4034	0.4863	0.0229	0.6319	0.7477
4	-55	0.4165	0.4144	0.0257	0.4942	0.6984
5	-45	0.4804	0.4731	0.0350	0.5162	0.7158
6	-35	0.5520	0.5397	0.0456	0.5540	0.7314
7	-25	0.6268	0.6144	0.0573	0.6147	0.7658
8	-15	0.7024	0.6928	0.0690	0.6901	0.8129
9	-5	0.7740	0.7666	0.0792	0.7649	0.8580
10	5	0.8327	0.8271	0.0857	0.8244	0.8925
11	15	0.8730	0.8692	0.0874	0.8653	0.9139
12	25	0.8932	0.8909	0.0843	0.8879	0.9250
13	35	0.8865	0.8890	0.0670	0.8980	0.9298
14	45	0.8498	0.8583	0.0646	0.8905	0.9292
15	55	0.7746	0.7805	0.0476	0.8236	0.9029
16	65	0.8091	0.8397	0.0412	1.3335	1.0743
17	75	235.1006	268.8062	7.0035	227.0836	2.2656
18	85	1.7144	725.7622	4.0367	458.9630	183.8327
(KrKs)eff		*0.7631*				

Table F.15. Combined shoaling/refraction coefficients at Site D for 2-D spectral components using cosine-squared spreading function (T_p = 7 s)

SITE D: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	353.3255	313.2571	154.8574	272.3224	0.4652
2	-75	0.3891	114.8989	104.5618	107.3150	0.3046
3	-65	0.2950	0.2738	0.5949	45.7528	0.5931
4	-55	0.3683	0.3749	0.3898	0.4038	0.4218
5	-45	0.4344	0.4298	0.4356	0.4440	0.4545
6	-35	0.5117	0.5004	0.5018	0.5059	0.5126
7	-25	0.5987	0.5861	0.5875	0.5902	0.5931
8	-15	0.6868	0.6789	0.6806	0.6825	0.6855
9	-5	0.7654	0.7625	0.7644	0.7658	0.7700
10	5	0.8269	0.8257	0.8269	0.8282	0.8313
11	15	0.8662	0.8656	0.8671	0.8684	0.8704
12	25	0.8860	0.8881	0.8897	0.8906	0.8922
13	35	0.8785	0.8903	0.8947	0.8976	0.8994
14	45	0.8281	0.8448	0.8537	0.8610	0.8673
15	55	0.7133	0.7182	0.7246	0.7294	0.7373
16	65	0.5878	0.6777	0.8676	0.9194	0.8402
17	75	145.4545	216.7221	159.3415	237.5312	0.6563
18	85	380.9524	379.3377	380.9524	663.3221	379.7432

SITE D: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	294.9743	278.8490	261.5087	22.9857	192.8456
2	-75	0.3444	17.2688	98.9163	0.9251	22.4185
3	-65	0.5772	0.6424	0.5676	0.5866	0.6413
4	-55	0.4465	0.4915	0.5737	0.6729	0.8656
5	-45	0.4723	0.5044	0.5767	0.6882	0.8940
6	-35	0.5221	0.5463	0.5996	0.7075	0.9243
7	-25	0.6017	0.6172	0.6603	0.7535	0.9523
8	-15	0.6917	0.7062	0.7396	0.8150	0.9704
9	-5	0.7747	0.7863	0.8119	0.8685	0.9818
10	5	0.8352	0.8438	0.8637	0.9060	0.9876
11	15	0.8735	0.8793	0.8941	0.9258	0.9911
12	25	0.8946	0.8984	0.9113	0.9380	0.9922
13	35	0.9033	0.9075	0.9193	0.9453	0.9940
14	45	0.8758	0.8860	0.9049	0.9365	0.9935
15	55	0.7470	0.7654	0.8015	0.8639	0.9799
16	65	0.8960	0.8738	0.9302	0.7979	0.8184
17	75	1.3702	2.5488	130.5039	2.4161	2.4359
18	85	379.6079	341.6530	340.7151	379.9294	74.6302

(KsKr)eff *0.7804*

Table F.16. Combined shoaling/refraction coefficients at Site D for 2-D spectral components using cosine-squared spreading function (T_p = 10 s)

SITE D: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	73.8784	187.9104	543.3491	0.3048	436.7756
2	-75	0.1236	45.1808	204.1913	0.1165	169.5468
3	-65	0.3777	0.3390	0.3192	0.4825	0.2958
4	-55	0.4604	0.4186	0.4042	0.3950	0.3881
5	-45	0.5467	0.4988	0.4811	0.4702	0.4615
6	-35	0.6313	0.5822	0.5648	0.5531	0.5416
7	-25	0.7025	0.6608	0.6458	0.6354	0.6257
8	-15	0.7614	0.7312	0.7200	0.7123	0.7061
9	-5	0.8138	0.7931	0.7857	0.7815	0.7770
10	5	0.8599	0.8439	0.8390	0.8364	0.8335
11	15	0.8921	0.8785	0.8752	0.8730	0.8708
12	25	0.8924	0.8839	0.8834	0.8839	0.8843
13	35	0.8588	0.8577	0.8611	0.8630	0.8647
14	45	0.8140	0.8124	0.8148	0.8157	0.8181
15	55	0.7529	0.7425	0.7359	0.7317	0.7280
16	65	0.6611	0.6377	0.6161	44.0462	0.6634
17	75	127.2691	144.8823	144.4043	160.6884	144.6984
18	85	753.2276	379.3377	670.9340	0.8952	378.8590

SITE D: 2-D (Cosine Squared Function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	370.7194	341.8457	319.0553	320.4806	224.6148
2	-75	108.3252	135.7439	110.6909	66.4982	10.6527
3	-65	0.3583	0.4300	0.4315	0.5465	0.6824
4	-55	0.3798	0.3711	0.3688	0.4160	0.6468
5	-45	0.4506	0.4393	0.4291	0.4514	0.6577
6	-35	0.5322	0.5175	0.5023	0.5108	0.6743
7	-25	0.6152	0.6028	0.5891	0.5926	0.7236
8	-15	0.6984	0.6898	0.6805	0.6842	0.7911
9	-5	0.7731	0.7675	0.7622	0.7687	0.8503
10	5	0.8308	0.8271	0.8245	0.8311	0.8925
11	15	0.8690	0.8672	0.8655	0.8693	0.9158
12	25	0.8848	0.8857	0.8873	0.8921	0.9282
13	35	0.8702	0.8762	0.8858	0.8980	0.9356
14	45	0.8214	0.8272	0.8393	0.8662	0.9265
15	55	0.7213	0.7156	0.7143	0.7354	0.8464
16	65	0.7009	0.7227	0.8135	1.1244	0.9730
17	75	0.5202	145.3514	268.8248	254.5055	2.1930
18	85	726.9620	722.2801	379.8956	413.6037	81.5260

(KrKs)eff *0.7498*

APPENDIX G:

Nearshore wave conditions for two-dimensional spectral components using Mitsuyasu spreading function (*note: highlighted cells denote neglected components*)

Table G.1. Nearshore wave conditions at Site A for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE ($T_p = 7$ s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.4041	-16.0797	5.0158	-19.1925	4.1441	-25.7790	4.4807	-23.9511	0.0035	-28.8324
2	-75	0.0035	-10.4379	0.0071	-19.0673	0.0060	-26.1256	4.0503	-27.3553	4.7815	-29.4834
3	-65	0.0110	-11.6739	0.0037	-18.6601	4.2788	-26.2494	0.0075	-27.9624	0.0088	-28.2456
4	-55	0.0321	-7.8358	0.0155	-14.7881	0.0096	-17.7880	0.0070	-19.9574	0.0081	-22.0762
5	-45	0.0475	-2.9550	0.0314	-9.2101	0.0234	-11.9276	0.0194	-13.8990	0.0214	-15.8291
6	-35	0.0646	2.2128	0.0537	-3.3069	0.0462	-5.7194	0.0419	-7.4775	0.0441	-9.2093
7	-25	0.0811	7.4608	0.0792	2.6193	0.0753	0.4881	0.0731	-1.0499	0.0745	-2.5707
8	-15	0.0945	12.7188	0.1022	8.5240	0.1041	6.6931	0.1052	5.3594	0.1053	4.0531
9	-5	0.1028	18.0527	0.1169	14.5182	0.1229	12.9921	0.1269	11.8698	0.1258	10.7566
10	5	0.1045	23.5473	0.1186	20.6370	0.1246	19.4525	0.1286	18.5412	0.1273	17.6483
11	15	0.0990	29.2751	0.1066	27.1039	0.1082	26.1434	0.1093	25.4385	0.1091	24.7477
12	25	0.0870	35.2655	0.0844	33.7862	0.0800	33.0985	0.0773	32.5957	0.0787	32.0938
13	35	0.0705	41.4759	0.0583	40.7197	0.0500	40.3207	0.0452	40.0091	0.0475	39.6916
14	45	0.0532	47.7000	0.0351	47.7779	0.0262	47.6825	0.0216	47.5782	0.0237	47.4609
15	55	0.0369	53.6599	0.0181	54.8280	0.0114	55.0210	0.0084	55.1447	0.0097	55.2417
16	65	0.0444	55.7462	0.0097	57.3139	0.0562	56.9674	0.0033	56.9103	0.0082	57.7709
17	75	6.7792	56.2118	0.0220	57.2736	0.0574	57.5200	0.0079	58.3328	0.0093	57.8588
18	85	0.0717	55.2506	4.0000	56.9512	4.0000	57.4664	0.0120	57.7923	4.0000	57.6166

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.0836	-31.4556	0.0044	-34.3565	3.6773	-43.5451	3.0993	-52.6638	3.4222	-63.0391
2	-75	0.0031	-26.9677	0.0140	-37.7717	3.0936	-43.1267	0.0185	-49.7642	0.1136	-37.8928
3	-65	0.0035	-28.9512	0.0053	-32.5192	0.0095	-40.3198	0.0217	-47.7001	0.0391	-70.8624
4	-55	0.0102	-24.6229	0.0139	-28.4712	0.0212	-34.9043	0.0337	-43.7128	0.0570	-53.6938
5	-45	0.0246	-18.1553	0.0296	-21.6790	0.0382	-27.5734	0.0511	-35.5473	0.0694	-43.9635
6	-35	0.0476	-11.2916	0.0526	-14.4618	0.0602	-19.7770	0.0703	-26.9352	0.0813	-34.2569
7	-25	0.0769	-4.4010	0.0797	-7.1965	0.0838	-11.9149	0.0887	-18.2217	0.0914	-24.4424
8	-15	0.1053	2.4637	0.1050	0.0433	0.1043	-4.0177	0.1040	-9.4635	0.0990	-14.5684
9	-5	0.1238	9.4193	0.1208	7.4041	0.1169	3.9911	0.1127	-0.5169	0.0957	-0.5969
10	5	0.1251	16.5655	0.1221	14.9289	0.1178	12.1785	0.1132	8.5562	0.1031	5.2490
11	15	0.1087	23.9124	0.1081	22.6407	0.1068	20.5138	0.1056	17.7310	0.0992	15.2152
12	25	0.0808	31.4859	0.0835	30.5560	0.0871	29.0026	0.0912	26.9801	0.0918	25.1658
13	35	0.0510	39.3040	0.0560	38.6976	0.0636	37.6684	0.0732	36.3212	0.0818	35.1201
14	45	0.0272	47.2938	0.0325	47.7223	0.0415	46.4872	0.0542	45.7813	0.0702	45.0809
15	55	0.0120	55.3184	0.0162	55.4529	0.0241	55.4872	0.0372	55.2430	0.0582	55.0303
16	65	0.0054	57.3888	0.0075	57.7358	0.0135	57.9392	0.0264	56.3681	0.0385	56.1387
17	75	0.0032	57.4769	0.0045	58.2163	0.0424	57.8570	0.0253	57.9934	0.1875	64.5561
18	85	6.0523	56.9548	0.0318	58.0553	0.0216	57.4563	5.2806	57.0682	4.5857	57.8220

Table G.2. Nearshore wave conditions at Site A for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE (T_p = 10 s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.0399	2.9063	7.5995	-2.5629	0.0035	-6.0139	6.9668	5.4573	2.8166	-1.8307
2	-75	0.0126	7.3241	6.7528	-5.9750	6.4588	-7.3399	0.0033	-0.4632	0.0146	-3.6138
3	-65	0.0197	5.1234	0.0062	0.9436	0.0034	0.0271	0.0033	-3.5501	0.0033	-1.8372
4	-55	0.0327	7.7116	0.0156	3.3747	0.0097	1.3739	0.0070	-0.1177	0.0082	-1.6267
5	-45	0.0496	10.7807	0.0321	6.9754	0.0240	5.2187	0.0196	3.9007	0.0215	2.5710
6	-35	0.0692	14.1919	0.0558	10.8870	0.0479	9.3600	0.0427	8.2132	0.0450	7.0521
7	-25	0.0886	17.8854	0.0836	15.0318	0.0793	13.7022	0.0751	12.7054	0.0764	11.6934
8	-15	0.1038	21.7114	0.1085	19.2807	0.1098	18.1391	0.1085	17.2718	0.1079	16.3913
9	-5	0.1120	25.5332	0.1237	23.5553	0.1296	22.6078	0.1309	21.8831	0.1289	21.1483
10	5	0.1132	29.3675	0.1254	27.8904	0.1316	27.1603	0.1330	26.5954	0.0032	26.0176
11	15	0.1064	33.3019	0.1126	32.3797	0.1145	31.8887	0.1134	31.4952	0.0032	31.0835
12	25	0.0923	37.3382	0.0885	37.0300	0.0844	36.8020	0.0802	36.6042	0.0033	36.3813
13	35	0.0734	41.3627	0.0603	41.7361	0.0520	41.8104	0.0465	41.8289	0.0099	41.8151
14	45	0.0531	45.1052	0.0352	46.2073	0.0265	46.6216	0.0217	46.8912	0.0240	47.1118
15	55	0.0353	48.3099	0.0176	50.2138	0.0111	51.0157	0.0080	51.5022	0.0461	51.9921
16	65	0.0216	51.0273	0.0072	52.0096	0.0037	52.4578	0.0037	53.6517	0.0611	54.6093
17	75	0.0130	50.2837	0.0046	52.9193	4.0000	54.1258	0.0033	52.6569	0.1633	55.1465
18	85	0.0082	51.1939	4.0000	53.9503	0.0055	54.1757	0.1567	53.8368	0.2326	53.5878

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	6.3745	-8.4007	1.7949	-9.0420	4.0000	-14.9192	4.0995	-29.9159	3.2086	-50.9057
2	-75	5.5007	-11.7463	6.5665	-13.6780	5.2698	-16.9260	1.7938	-30.6532	0.0619	-49.1224
3	-65	0.0035	-6.5564	0.0052	-8.7524	0.0115	-17.0194	0.0180	-30.4947	0.0463	-45.9810
4	-55	0.0101	-3.5127	0.0135	-6.5288	0.0203	-12.1316	0.0310	-21.4948	0.0492	-41.3646
5	-45	0.0245	0.8987	0.0291	-1.7849	0.0369	-6.8117	0.0474	-15.2982	0.0614	-33.4490
6	-35	0.0477	5.5911	0.0520	3.2399	0.0583	-1.1869	0.0652	-8.7358	0.0726	-25.0639
7	-25	0.0772	10.4203	0.0789	8.3563	0.0807	4.4739	0.0819	-2.1572	0.0823	-16.5947
8	-15	0.1059	15.2881	0.1036	13.5013	0.1001	10.1416	0.0952	4.4184	0.0896	-8.0263
9	-5	0.1245	20.2180	0.1195	18.7125	0.1122	15.8880	0.1033	11.0633	0.0937	0.6555
10	5	0.1266	25.2798	0.1216	24.0781	0.1140	21.7961	0.1045	17.8924	0.0943	9.4895
11	15	0.1109	30.5583	0.1086	29.6714	0.1046	27.9463	0.0986	24.9374	0.0912	18.4418
12	25	0.0828	36.0725	0.0846	35.5185	0.0863	34.3714	0.0865	32.2307	0.0849	27.4985
13	35	0.0520	41.7572	0.0567	41.5799	0.0635	41.0416	0.0701	39.7784	0.0760	36.6686
14	45	0.0274	47.3486	0.0327	47.6216	0.0414	47.8007	0.0524	47.4958	0.0656	45.9642
15	55	0.0118	52.4895	0.0160	53.3473	0.0237	54.4972	0.0357	55.2214	0.0546	55.2663
16	65	0.0042	54.6928	0.0068	55.3151	0.0132	56.8071	0.0278	57.7192	0.0559	56.3161
17	75	4.0000	55.6056	6.6762	56.0818	0.1034	56.8776	1.6446	58.3294	0.0583	56.7231
18	85	6.5859	55.1110	4.0000	55.2565	4.0000	57.1354	0.0181	57.6334	6.8759	57.7658

Table G.3. Nearshore wave conditions at Site B for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE ($T_p = 7$ s)

SITE B: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
Angle Bands		Frequency Bands (T_p = 7s, i =1 to 5)									
		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.4645	-2.8441	5.1598	-7.3020	4.2095	-14.2380	4.3954	-12.9244	0.0034	-18.1627
2	-75	0.0035	1.6977	0.0081	-7.1978	0.0062	-14.5290	4.0223	-16.2983	4.4112	-18.8970
3	-65	0.0099	0.7511	0.0037	-6.8427	4.2002	-14.6093	0.0066	-16.8811	0.0065	-17.6441
4	-55	0.0275	3.6404	0.0140	-3.6096	0.0089	-6.9521	0.0066	-9.4297	0.0077	-11.8904
5	-45	0.0394	7.0591	0.0275	0.7903	0.0210	-2.1233	0.0177	-4.2986	0.0196	-6.4771
6	-35	0.0528	10.4949	0.0457	5.1135	0.0402	2.6124	0.0369	0.7406	0.0393	-1.4460
7	-25	0.0672	13.9888	0.0672	9.3183	0.0648	7.1547	0.0635	5.5563	0.0654	3.9355
8	-15	0.0812	17.6941	0.0888	13.6262	0.0912	11.7814	0.0927	10.4105	0.0935	9.0438
9	-5	0.0926	21.8113	0.1057	18.3323	0.1116	16.7787	0.1156	15.6231	0.1149	14.4711
10	5	0.0981	26.4580	0.1116	23.5951	0.1174	22.3139	0.1214	21.3645	0.1203	20.4327
11	15	0.0957	31.6646	0.1033	29.4538	0.1050	28.4475	0.1064	27.7007	0.1060	26.9579
12	25	0.0856	37.3769	0.0833	35.8584	0.0790	35.1280	0.0764	34.5833	0.0778	34.0317
13	35	0.0701	43.4505	0.0581	42.6872	0.0499	42.2497	0.0451	41.9042	0.0474	41.5432
14	45	0.0525	49.6040	0.0350	49.7373	0.0261	49.6244	0.0216	49.4885	0.0237	49.3280
15	55	0.0358	55.3762	0.0178	56.4089	0.0112	56.7863	0.0082	56.9602	0.0095	57.0542
16	65	0.0373	57.3969	0.0084	59.0266	0.0538	58.7162	0.0032	58.7823	0.0124	59.3770
17	75	4.0000	58.0716	0.0278	59.0444	0.0554	59.5605	0.0115	60.1717	0.0115	59.3799
18	85	0.0559	56.9856	4.0000	58.4107	4.0000	59.3089	0.0096	59.5949	4.1732	58.9209

SITE B: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
Angle Bands		Frequency Bands (T_p = 7s, i =6 to 10)									
		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.3592	-21.3280	0.0042	-25.0711	3.5108	-36.0134	2.7704	-47.0633	2.4101	-54.4870
2	-75	0.0031	-17.0839	0.0131	-29.1990	2.9853	-36.0364	0.0158	-47.3786	0.0762	-60.6608
3	-65	0.0034	-18.7952	0.0053	-23.1102	0.0094	-32.9333	0.0183	-41.7755	0.0291	-56.5682
4	-55	0.0097	-14.8869	0.0133	-19.4668	0.0203	-27.1764	0.0321	-37.8557	0.0551	-52.0029
5	-45	0.0228	-9.1541	0.0278	-13.3011	0.0365	-20.4057	0.0490	-30.3678	0.0681	-42.7292
6	-35	0.0429	-3.4674	0.0483	-7.1087	0.0565	-13.4381	0.0672	-22.4793	0.0803	-33.3541
7	-25	0.0682	1.9527	0.0719	-1.1643	0.0777	-6.6654	0.0847	-14.5712	0.0909	-23.8218
8	-15	0.0941	7.3548	0.0952	4.7118	0.0968	0.0715	0.0996	-6.6366	0.0986	-14.1307
9	-5	0.1135	13.0555	0.1118	10.8609	0.1099	7.0252	0.1086	1.5765	0.0923	1.5765
10	5	0.1185	19.2674	0.1160	17.4823	0.1129	14.3958	0.1102	10.0755	0.1209	5.4910
11	15	0.1057	26.0471	0.1053	24.6369	0.1044	22.2144	0.1038	18.8674	0.0990	15.3861
12	25	0.0800	33.3530	0.0826	32.2930	0.0863	30.4572	0.0905	27.9204	0.0917	25.2980
13	35	0.0509	41.0853	0.0559	40.3475	0.0635	39.0371	0.0729	37.1831	0.0817	35.2283
14	45	0.0271	49.0926	0.0324	48.7029	0.0415	47.8796	0.0542	46.6193	0.0702	45.1811
15	55	0.0119	57.0764	0.0160	57.0271	0.0239	56.6231	0.0371	56.1724	0.0582	55.1455
16	65	0.0049	58.8372	0.0073	59.3065	0.0140	59.3502	0.0252	57.6615	0.0375	57.1416
17	75	0.0032	58.7373	0.0054	59.6528	0.0631	59.1331	0.0229	57.5493	0.0956	49.0257
18	85	4.0000	59.4168	0.0377	58.9969	0.0315	59.2346	5.6170	57.9177	6.6008	57.0196

Table G.4. Nearshore wave conditions at Site B for 2-D spectral components using Mistsuyasu spreading function from RCPWAVE (T_p = 10 s)

SITE B: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.0302	14.1271	6.6111	10.0461	0.0034	7.3291	6.0958	7.2558	2.6116	8.7202
2	-75	0.0096	16.6376	6.3625	7.9702	5.8599	6.4614	0.0032	10.4914	0.0119	8.1120
3	-65	0.0150	15.3948	0.0050	12.1122	0.0033	11.1260	0.0032	8.5107	0.0032	9.2714
4	-55	0.0249	16.8641	0.0123	13.5627	0.0079	11.9519	0.0059	10.7081	0.0069	9.4108
5	-45	0.0384	18.6450	0.0250	15.6925	0.0190	14.2744	0.0157	13.1825	0.0173	12.0538
6	-35	0.0552	20.7424	0.0443	18.0716	0.0381	16.8055	0.0340	15.8377	0.0359	14.8424
7	-25	0.0735	23.1810	0.0687	20.7508	0.0650	19.6027	0.0615	18.7308	0.0626	17.8367
8	-15	0.0897	25.9017	0.0933	23.7327	0.0943	22.7017	0.0930	21.9144	0.0925	21.1108
9	-5	0.1010	28.8518	0.1114	27.0188	0.1166	26.1349	0.1178	25.4568	0.1160	24.7640
10	5	0.1055	32.0663	0.1173	30.6641	0.1231	29.9672	0.1245	29.4265	0.0032	28.8677
11	15	0.1017	35.5726	0.1081	34.6951	0.1101	34.2254	0.1091	33.8483	0.0032	33.4505
12	25	0.0898	39.3210	0.0865	39.0514	0.0826	38.8480	0.0785	38.6652	0.0033	38.4564
13	35	0.0717	43.1409	0.0592	43.5607	0.0512	43.6635	0.0459	43.7085	0.0098	43.7207
14	45	0.0517	46.6684	0.0344	47.8238	0.0260	48.2802	0.0214	48.5861	0.0236	48.8629
15	55	0.0342	49.7422	0.0171	51.4998	0.0108	52.2712	0.0079	52.8104	0.0446	53.3387
16	65	0.0207	52.1907	0.0067	53.2339	0.0036	53.7982	0.0034	55.1352	0.0531	56.1490
17	75	0.0122	51.4061	0.0041	54.2795	4.0000	55.9276	0.0033	53.8175	0.1402	56.9839
18	85	0.0069	52.3700	4.0000	55.5397	0.0049	55.7389	0.1223	55.2780	0.1377	54.8656

SITE B: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	6.3040	4.4194	1.5602	3.0738	5.3553	-3.0004	4.2892	-19.1395	3.1718	-44.4147
2	-75	5.4515	1.9972	6.1628	-0.3466	5.2571	-4.4737	1.7214	-20.1649	0.0480	-43.6015
3	-65	0.0034	5.6475	0.0046	3.3060	0.0106	-4.6997	0.0175	-20.0677	0.0401	-39.9421
4	-55	0.0085	7.7329	0.0116	4.9137	0.0180	-0.7501	0.0292	-11.2120	0.0470	-34.9730
5	-45	0.0199	10.5957	0.0241	8.1593	0.0137	3.2693	0.0432	-5.8744	0.0589	-27.6874
6	-35	0.0383	13.5631	0.0422	11.4456	0.0488	7.2358	0.0577	-0.6239	0.0691	-20.0386
7	-25	0.0634	16.6974	0.0651	14.8203	0.0678	11.1466	0.0716	4.3777	0.0779	-12.4525
8	-15	0.0907	20.0974	0.0888	18.4324	0.0865	15.2163	0.0843	9.4253	0.0851	-4.8047
9	-5	0.1120	23.8836	0.1076	22.4470	0.1012	19.6907	0.0942	14.7889	0.0898	3.0381
10	5	0.1187	28.1537	0.1140	26.9798	0.1071	24.7124	0.0987	20.6823	0.0914	11.2244
11	15	0.1069	32.9333	0.1049	32.0593	0.1013	30.3200	0.0958	27.1627	0.0895	19.7506
12	25	0.0813	38.1628	0.0833	37.6296	0.0851	36.4679	0.0855	34.1835	0.0841	28.5894
13	35	0.0516	43.6841	0.0564	43.5431	0.0632	43.0257	0.0700	41.6441	0.0757	37.6760
14	45	0.0269	49.1496	0.0322	49.4976	0.0411	49.7633	0.0523	49.3759	0.0655	46.9633
15	55	0.0115	54.0365	0.0154	55.0017	0.0231	56.1222	0.0355	57.0370	0.0546	56.3702
16	65	0.0042	56.3582	0.0067	56.8223	0.0125	58.3520	0.0272	59.3763	0.0528	58.1551
17	75	4.0000	57.3450	5.0085	57.4492	0.0364	58.7880	2.7212	60.2081	0.0687	58.9945
18	85	4.0000	56.5408	4.0000	56.8917	4.0000	58.6177	0.0130	58.8798	4.0000	58.5022

Table G.5. Nearshore wave conditions at Site C for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE (T_p = 7 s)

SITE C: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =1 to 5)									
Angle Bands		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	3.2568	-1.2605	4.3144	-2.7956	3.5474	-6.3447	3.6586	-7.0766	0.0031	-10.2987
2	-75	0.0032	2.5070	0.0081	-2.7805	0.0050	-6.2161	3.8214	-8.2851	3.6599	-10.4316
3	-65	0.0058	2.1915	0.0032	-2.6013	2.9293	-6.5016	0.0042	-8.4303	0.0047	-9.6874
4	-55	0.0173	3.2263	0.0089	-1.4829	0.0059	-3.8137	0.0046	-5.6348	0.0054	-7.5371
5	-45	0.0276	4.7047	0.0187	0.3307	0.0145	-1.7699	0.0124	-3.3860	0.0139	-5.0582
6	-35	0.0417	6.5825	0.0347	2.4857	0.0303	0.5660	0.0279	-0.8854	0.0298	-2.3689
7	-25	0.0591	9.0064	0.0573	5.1833	0.0548	3.4253	0.0535	2.1214	0.0551	0.7968
8	-15	0.0074	12.1263	0.0834	8.6638	0.0851	7.1069	0.0863	5.9504	0.0867	4.8000
9	-5	0.0926	16.0747	0.1053	13.1061	0.1109	11.7868	0.1147	10.8118	0.1138	9.8443
10	5	0.1000	20.8437	0.1140	18.4986	0.1199	17.4494	0.1240	16.6753	0.1228	15.9091
11	15	0.0975	26.2762	0.1057	24.6503	0.1076	23.8961	0.1087	23.3354	0.1086	22.7768
12	25	0.0862	32.1292	0.0844	31.2932	0.0802	30.8517	0.0777	30.5096	0.0792	30.1594
13	35	0.0691	38.1155	0.0580	38.1639	0.0499	38.0589	0.0452	37.9445	0.0476	37.8067
14	45	0.0504	43.8722	0.0341	44.9778	0.0256	45.2719	0.0213	45.4148	0.0234	45.5229
15	55	0.0326	48.8453	0.0164	50.9147	0.0105	51.6833	0.0078	52.1149	0.0090	52.5077
16	65	0.0260	50.6908	0.0069	52.9833	0.0323	53.6202	0.0031	54.0714	0.0132	54.6027
17	75	6.7844	51.4640	0.0348	53.1744	0.0432	54.4375	0.0140	55.0303	0.0120	54.2388
18	85	0.0353	50.4218	4.0000	52.5790	4.0000	53.9262	0.0063	54.2414	6.2767	54.1529

SITE C: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 7s, i =6 to 10)									
Angle Bands		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	3.4761	-13.1117	0.0034	-16.9982	3.5228	-27.3314	2.7687	-40.5789	2.0098	-53.3548
2	-75	0.0031	-11.0202	0.0103	-19.1893	2.4912	-27.4390	0.0155	-42.2246	0.1193	-56.0001
3	-65	0.0032	-11.7219	0.0044	-15.9695	0.0081	-25.3595	0.0162	-36.3886	0.0292	-56.2982
4	-55	0.0070	-9.9875	0.0100	-14.0370	0.0165	-21.6640	0.0284	-33.4693	0.0526	-50.3541
5	-45	0.0164	-7.1934	0.0207	-10.6974	0.0293	-17.2978	0.0431	-27.6430	0.0659	-41.8016
6	-35	0.0327	-4.2385	0.0375	-7.2614	0.0462	-12.8632	0.0598	-21.5820	0.0787	-33.0104
7	-25	0.0574	-0.8403	0.0609	-3.4520	0.0675	-8.1769	0.0779	-15.2493	0.0899	-23.8462
8	-15	0.0872	3.3805	0.0882	1.1583	0.0903	-2.7288	0.0953	-8.2940	0.0982	-14.3176
9	-5	0.1123	8.6587	0.1104	6.8382	0.1083	3.7290	0.1073	-0.4811	0.0912	-0.4811
10	5	0.1208	14.9748	0.1182	13.5484	0.1145	11.1567	0.1109	8.0428	0.1029	5.2467
11	15	0.1084	22.0940	0.1079	21.0485	0.1066	19.2997	0.1052	17.0619	0.0991	15.1503
12	25	0.0814	29.7222	0.0841	29.0365	0.0877	27.8699	0.0915	26.3573	0.0917	25.0878
13	35	0.0512	37.6144	0.0564	37.2791	0.0640	36.6473	0.0734	35.7729	0.0818	35.0383
14	45	0.0269	45.5941	0.0323	45.6164	0.0414	45.5126	0.0542	45.2305	0.0701	44.9817
15	55	0.0113	52.9532	0.0152	53.4387	0.0229	53.9983	0.0362	54.4016	0.0580	54.8968
16	65	0.0047	54.7917	0.0070	55.5557	0.0138	56.0893	0.0218	56.0747	0.0369	56.5099
17	75	0.0032	54.2144	0.0063	55.7954	0.0540	56.0160	0.0199	55.8328	0.0844	56.7329
18	85	4.0000	55.6491	0.0340	55.2879	0.0429	56.7406	5.0231	57.2161	2.5781	57.7170

Table G.6. Nearshore wave conditions at Site C for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE (T_p = 10 s)

SITE C: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.0212	10.3791	5.2824	8.0686	0.0031	6.7429	4.2898	6.3076	2.3175	6.1856
2	-75	0.0076	11.7744	4.7683	7.5177	4.0228	6.5499	0.0031	7.6086	0.0076	6.3167
3	-65	0.0113	11.0448	0.0036	8.8726	0.0032	8.1288	0.0031	6.7637	0.0031	6.8040
4	-55	0.0200	11.9222	0.0092	9.6051	0.0058	8.5273	0.0043	7.7111	0.0049	6.8757
5	-45	0.0330	13.1436	0.0203	10.8698	0.0150	9.8166	0.0132	9.0202	0.0132	8.2079
6	-35	0.0501	14.7739	0.0388	12.5523	0.0328	11.5237	0.0289	10.7472	0.0301	9.9576
7	-25	0.0694	16.8494	0.0639	14.7222	0.0599	13.7307	0.0563	12.9823	0.0569	12.2218
8	-15	0.0871	19.3152	0.0905	17.3930	0.0913	16.4820	0.0899	15.7889	0.0892	15.0852
9	-5	0.1003	22.1483	0.1111	20.5668	0.1165	19.8024	0.1178	19.2166	0.1161	18.6170
10	5	0.1057	25.3517	0.1183	24.2453	0.1245	23.6887	0.1262	23.2547	0.0032	22.8039
11	15	0.1018	28.8728	0.1087	28.3426	0.1110	28.0417	0.1103	27.7943	0.0032	27.5271
12	25	0.0885	32.5660	0.0857	32.6789	0.0820	32.6686	0.0782	32.6347	0.0033	32.5786
13	35	0.0689	36.1148	0.0572	36.9180	0.0497	37.2313	0.0446	37.4432	0.0096	37.6303
14	45	0.0489	39.2748	0.0327	40.7646	0.0249	41.4141	0.0204	41.8786	0.0226	42.3240
15	55	0.0323	42.0420	0.0161	44.1494	0.0102	45.0930	0.0075	45.7674	0.0412	46.4180
16	65	0.0195	44.3623	0.0061	45.6723	0.0035	46.3614	0.0033	47.7888	0.0400	48.8455
17	75	0.0116	43.6033	0.0034	46.5040	4.0000	48.6393	0.0033	46.3781	0.1161	49.6964
18	85	0.0051	44.5589	4.0000	47.9527	0.0041	48.3182	0.0751	47.9491	0.0643	47.4911

SITE C: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.5267	4.6216	1.0317	3.3013	5.2485	-0.4074	3.8947	-10.2675	3.2868	-37.4002
2	-75	3.9421	4.0107	4.5389	2.4491	3.9290	-0.7820	1.4791	-10.6939	0.0420	-36.7577
3	-65	0.0032	4.9846	0.0032	3.4266	0.0067	-0.8904	0.0141	-10.5608	0.0350	-33.8361
4	-55	0.0058	5.8067	0.0075	4.0296	0.0113	0.4175	0.0196	-7.0033	0.0408	-30.1925
5	-45	0.0148	7.1726	0.0172	5.4683	0.0217	2.0744	0.0299	-4.5905	0.0505	-24.7587
6	-35	0.0315	8.9529	0.0338	7.3144	0.0375	4.0999	0.0434	-1.9554	0.0600	-19.1537
7	-25	0.0571	11.2597	0.0577	9.6937	0.0585	6.6742	0.0603	1.1603	0.0705	-13.3189
8	-15	0.0872	14.2011	0.0849	12.7607	0.0817	10.0098	0.0783	5.1193	0.0809	-6.7907
9	-5	0.1121	17.8574	0.1076	16.6198	0.1010	14.2602	0.0934	10.1104	0.0887	0.6142
10	5	0.1207	22.2258	0.1162	21.2693	0.1094	19.4127	0.1007	16.1196	0.0922	8.8366
11	15	0.1085	27.1731	0.1068	26.5589	0.1035	25.2947	0.0982	22.9308	0.0909	17.6267
12	25	0.0814	32.4782	0.0837	32.2516	0.0861	31.6473	0.0870	30.2567	0.0852	26.7391
13	35	0.0505	37.8300	0.0555	38.0550	0.0629	38.1996	0.0703	37.8464	0.0763	35.9962
14	45	0.0258	42.8421	0.0309	43.5860	0.0398	44.6337	0.0516	45.4987	0.0655	45.3095
15	55	0.0107	47.1997	0.0142	48.3663	0.0212	50.1963	0.0326	52.4080	0.0528	54.3412
16	65	0.0039	49.4591	0.0061	49.9790	0.0113	51.8447	0.0238	54.6606	0.0504	56.4756
17	75	4.0000	50.0773	6.5833	50.6251	0.0135	52.5164	3.6040	54.9872	0.0803	57.3337
18	85	6.7542	49.2087	5.8525	50.2665	7.2906	52.4864	0.0101	53.6718	4.0000	57.2198

Table G.7. Nearshore wave conditions at Site D for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE ($T_p = 7$ s)

SITE D: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
Angle Bands		Frequency Bands (T_p = 7s, i =1 to 5)									
		T_1 = 8.5413s		T_2 = 7.5807s		T_3 = 7.2245s		T_4 = 6.9834s		T_5 = 6.7583s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	2.8675	5.0291	3.8491	1.1413	3.1364	-1.6904	3.2340	-2.7408	0.0031	-5.3304
2	-75	0.0032	5.8450	0.0078	-1.1560	0.0049	-1.5733	2.8456	-3.4844	3.1993	-5.3639
3	-65	0.0051	5.6170	0.0032	1.2788	2.3967	-1.7803	0.0033	-3.5312	0.0039	-4.8227
4	-55	0.0154	6.3920	0.0077	2.0266	0.0052	-0.0932	0.0040	-1.7407	0.0047	-3.4627
5	-45	0.0255	7.5994	0.0169	3.4021	0.0130	1.4201	0.0111	-0.0937	0.0123	-1.6547
6	-35	0.0398	9.2444	0.0326	5.2022	0.0283	3.3304	0.0259	1.9239	0.0275	0.4923
7	-25	0.0580	11.5074	0.0558	7.6607	0.0531	5.9063	0.0517	4.6056	0.0530	3.2909
8	-15	0.0771	14.5553	0.0831	11.0422	0.0846	9.4640	0.0857	8.2935	0.0860	7.1273
9	-5	0.0928	18.5095	0.1051	15.5083	0.1115	14.1645	0.1154	13.1691	0.1144	12.1774
10	5	0.1001	23.3028	0.1147	20.9722	0.1207	19.9106	0.1248	19.1213	0.1237	18.3326
11	15	0.0974	28.7342	0.1061	27.1772	0.1080	26.4287	0.1092	25.8619	0.1092	25.2876
12	25	0.0857	34.5416	0.0845	33.8386	0.0804	33.4260	0.0780	33.0927	0.0795	32.7377
13	35	0.0682	40.4009	0.0577	40.6745	0.0499	40.6363	0.0453	40.5526	0.0477	40.4294
14	45	0.0486	45.8337	0.0330	47.1778	0.0250	47.5733	0.0208	47.7788	0.0230	47.9393
15	55	0.0298	50.2402	0.0149	52.3740	0.0097	53.1250	0.0072	53.6062	0.0084	54.0381
16	65	0.0195	51.7925	0.0058	54.0533	0.0193	55.0051	0.0031	55.3757	0.0107	55.7002
17	75	4.0000	52.5793	0.0373	54.3112	0.0315	55.4977	0.0135	56.1270	0.0107	55.3141
18	85	0.0246	51.6985	4.0000	53.9761	4.0000	54.9169	0.0045	55.4397	4.9499	55.4731

SITE D: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
Angle Bands		Frequency Bands (T_p = 7s, i =6 to 10)									
		T_6 = 6.5001s		T_7 = 6.1304s		T_8 = 5.5518s		T_9 = 4.7819s		T_{10}= 3.4995s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	3.0305	-7.8878	0.0031	-11.6269	3.2823	-21.5421	2.5090	-34.9641	2.8843	-56.3955
2	-75	0.0031	-6.4208	0.0089	-13.3696	2.3188	-21.6884	0.0139	-36.9196	0.3906	-60.8997
3	-65	0.0032	-6.8816	0.0039	-10.8558	0.0075	-19.8654	0.0147	-31.1989	0.0264	-53.1909
4	-55	0.0061	-5.6926	0.0088	-9.4333	0.0149	-16.7328	0.0265	-28.6399	0.0503	-47.7372
5	-45	0.0145	-3.6451	0.0183	-6.9259	0.0263	-13.2344	0.0398	-23.6263	0.0632	-39.9219
6	-35	0.0301	-1.3075	0.0343	-4.2183	0.0423	-9.6644	0.0555	-18.4814	0.0762	-31.7601
7	-25	0.0550	1.6671	0.0580	-0.9221	0.0639	-5.6418	0.0738	-12.9717	0.0881	-23.1179
8	-15	0.0862	5.6872	0.0869	3.4257	0.0884	-0.5892	0.0926	-6.5663	0.0971	-13.9136
9	-5	0.1128	10.9576	0.1107	9.0598	0.1081	5.7403	0.1063	0.9795	0.0903	0.9795
10	5	0.1217	17.3615	0.1189	15.8468	0.1150	13.1997	0.1108	9.4370	0.1027	5.4440
11	15	0.1090	24.5715	0.1085	23.4373	0.1071	21.4115	0.1053	18.4657	0.0991	15.3351
12	25	0.0818	32.2753	0.0845	31.5083	0.0882	30.0540	0.0918	27.8010	0.0918	25.2815
13	35	0.0514	40.2323	0.0567	39.8362	0.0644	38.9295	0.0738	37.2924	0.0819	35.2552
14	45	0.0265	48.0489	0.0319	48.0807	0.0412	47.7854	0.0542	46.7959	0.0702	45.2095
15	55	0.0105	54.4760	0.0140	54.9664	0.0212	55.4510	0.0343	55.4702	0.0574	55.0163
16	65	0.0045	56.2292	0.0062	56.7393	0.0123	57.5078	0.0198	57.6384	0.0381	57.3258
17	75	0.0031	55.6929	0.0066	57.1659	0.0325	57.1939	0.0219	57.4093	0.0774	57.5300
18	85	4.0000	56.9120	0.0265	56.7352	0.0437	58.1404	4.0000	58.6289	2.6059	58.2904

Table G.8. Nearshore wave conditions at Site D for 2-D spectral components using Mitsuyasu spreading function from RCPWAVE ($T_p = 10$ s)

SITE D: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =1 to 5)									
Angle Bands		T_1 = 12.1982s		T_2 = 10.8275s		T_3 = 10.3162s		T_4 = 9.9704s		T_5 = 9.6488s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	0.0197	13.4242	4.8824	11.2360	0.0031	10.0329	3.9881	9.5456	2.2750	9.2573
2	-75	0.0072	14.6503	4.5178	10.8386	3.6807	9.9062	0.0031	10.5995	0.0069	9.4157
3	-65	0.0107	14.0036	0.0035	11.8931	0.0032	11.1378	0.0031	9.9001	0.0031	9.8157
4	-55	0.0192	14.7881	0.0088	12.5265	0.0056	11.4791	0.0041	10.6876	0.0047	9.8799
5	-45	0.0320	15.9137	0.0195	13.6592	0.0144	12.6169	0.0117	11.8302	0.0126	11.0291
6	-35	0.0490	17.4538	0.0378	15.2217	0.0319	14.1880	0.0281	13.4080	0.0291	12.6156
7	-25	0.0680	19.4364	0.0628	17.2926	0.0590	16.2891	0.0555	15.5315	0.0560	14.7609
8	-15	0.0855	21.7972	0.0894	19.8800	0.0904	18.9643	0.0892	18.2659	0.0886	17.5553
9	-5	0.0987	24.5297	0.1100	22.8931	0.1157	22.2297	0.1171	21.6502	0.1157	21.0549
10	5	0.1043	27.6389	0.1172	26.5916	0.1236	26.0609	0.1254	25.6454	0.0032	25.2119
11	15	0.1004	31.0699	0.1076	30.6100	0.1100	30.3450	0.1094	30.1250	0.0032	29.8850
12	25	0.0864	34.6153	0.0840	34.8092	0.0807	34.8455	0.0771	34.8490	0.0033	34.8324
13	35	0.0669	37.9447	0.0558	38.8236	0.0486	39.1885	0.0437	39.4452	0.0095	39.6812
14	45	0.0477	40.9339	0.0319	42.4723	0.0242	43.1537	0.0200	43.6450	0.0220	44.1209
15	55	0.0315	43.5926	0.0156	45.6667	0.0100	46.5881	0.0072	47.2441	0.0388	47.8851
16	65	0.0189	45.8084	0.0059	47.0538	0.0034	47.7562	0.0033	49.1223	0.0315	49.9877
17	75	0.0115	45.0589	0.0034	47.8128	7.9416	50.0145	0.0033	47.7234	0.1021	50.8987
18	85	0.0051	44.5589	4.0000	49.2434	0.0036	49.7064	0.0505	49.2141	0.0377	48.6971

SITE D: 2-D (Mitsuyasu Function) NEARSHORE WAVE CHARACTERISTICS											
		Frequency Bands (T_p = 10s, i =6 to 10)									
Angle Bands		T_6 = 9.2790s		T_7 = 8.7507s		T_8 = 7.9220s		T_9 = 6.8190s		T_{10}= 4.9906s	
Band	Θ_{oj}[°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]	H_{ij} [m]	Θ_{ij} [°]
1	-85	4.0727	7.9203	0.9308	6.5877	4.8788	3.1769	3.4515	-5.1281	3.0561	-31.9866
2	-75	3.5204	7.5136	4.0227	6.0256	3.3737	2.9422	1.3141	-5.3881	0.0373	-31.1562
3	-65	0.0032	8.1913	0.0032	6.6875	0.0057	2.8776	0.0123	-5.2981	0.0320	-28.5523
4	-55	0.0055	8.8510	0.0068	7.1550	0.0099	3.7725	0.0166	-2.9791	0.0378	-25.2676
5	-45	0.0139	10.0107	0.0160	8.3427	0.0198	5.0628	0.0263	-1.2186	0.0464	-20.6580
6	-35	0.0304	11.6088	0.0324	9.9720	0.0355	6.7872	0.0401	0.8909	0.0554	-15.9661
7	-25	0.0561	13.7859	0.0566	12.2016	0.0571	9.1584	0.0580	3.6519	0.0667	-10.9205
8	-15	0.0867	16.6603	0.0846	15.1985	0.0814	12.4062	0.0777	7.4505	0.0787	-4.9186
9	-5	0.1120	20.2977	0.1078	19.0573	0.1015	16.6771	0.0939	12.4507	0.0880	2.2596
10	5	0.1204	24.6527	0.1163	23.7205	0.1098	21.8869	0.1015	18.5501	0.0923	10.4417
11	15	0.1080	29.5630	0.1065	28.9983	0.1037	27.8033	0.0987	25.4469	0.0911	19.2573
12	25	0.0806	34.7826	0.0831	34.6337	0.0860	34.1498	0.0873	32.8380	0.0855	28.4187
13	35	0.0496	39.9469	0.0546	40.2822	0.0623	40.6344	0.0704	40.4666	0.0767	37.7624
14	45	0.0251	44.6837	0.0299	45.5081	0.0384	46.7398	0.0502	47.9031	0.0654	47.1155
15	55	0.0103	48.6495	0.0133	49.7811	0.0194	51.6136	0.0292	53.9198	0.0494	55.5326
16	65	0.0037	50.6948	0.0055	51.1840	0.0101	52.8558	0.0208	55.8384	0.0456	57.5366
17	75	4.0000	51.2434	7.4773	51.8734	0.0039	53.6753	3.4618	56.0051	0.0754	58.0462
18	85	4.0001	50.4349	5.2145	51.5044	7.1226	53.6741	0.0091	55.1411	4.0000	58.6293

Table G.9. Combined shoaling/refraction coefficients at Site A for 2-D spectral components using Mitsuyasu spreading function (T_p = 7 s)

SITE A: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	367.4136	4401.3659	13755.4116	36219.9834	18.9801
2	-75	0.1883	2.0338	4.6008	5971.0738	5280.0338
3	-65	0.3900	0.4090	953.9558	2.6563	1.9424
4	-55	0.7739	0.7710	0.7661	0.7619	0.7613
5	-45	0.8140	0.8121	0.8097	0.8122	0.8172
6	-35	0.8322	0.8288	0.8296	0.8308	0.8323
7	-25	0.8378	0.8332	0.8326	0.8354	0.8361
8	-15	0.8407	0.8343	0.8355	0.8364	0.8390
9	-5	0.8482	0.8410	0.8410	0.8421	0.8453
10	5	0.8622	0.8532	0.8526	0.8534	0.8554
11	15	0.8808	0.8702	0.8684	0.8690	0.8693
12	25	0.8988	0.8879	0.8845	0.8834	0.8832
13	35	0.9082	0.8998	0.8979	0.8962	0.8965
14	45	0.9116	0.9078	0.9066	0.9043	0.9050
15	55	0.8896	0.9003	0.9098	0.9143	0.9117
16	65	1.5743	1.0721	12.5298	1.1688	2.3423
17	75	364.8062	6.3020	44.0143	11.6464	10.1724
18	85	5.9816	3510.0011	13277.1037	97.0027	21691.5045

SITE A: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	12235.0034	5.8718	1576.6697	418.8442	123.1081
2	-75	2.1752	5.3913	523.8206	1.3035	3.1027
3	-65	0.7261	0.7163	0.7154	0.8774	0.8319
4	-55	0.7709	0.7870	0.8115	0.8547	0.9727
5	-45	0.8200	0.8262	0.8416	0.8839	0.9813
6	-35	0.8359	0.8429	0.8585	0.8986	0.9866
7	-25	0.8417	0.8479	0.8658	0.9056	0.9878
8	-15	0.8438	0.8509	0.8706	0.9147	0.9900
9	-5	0.8497	0.8569	0.8776	0.9208	0.9202
10	5	0.8586	0.8661	0.8844	0.9248	0.9913
11	15	0.8710	0.8760	0.8915	0.9288	0.9920
12	25	0.8843	0.8883	0.8999	0.9311	0.9922
13	35	0.8957	0.8974	0.9070	0.9357	0.9927
14	45	0.9067	0.9071	0.9143	0.9375	0.9926
15	55	0.9070	0.9172	0.9225	0.9434	0.9932
16	65	1.1202	1.0137	1.0166	1.0675	0.8191
17	75	2.2454	1.7329	7.1793	1.7826	5.1211
18	85	18133.4878	42.4370	9.5200	713.6285	164.9631

(KsKr)eff *0.8731*

Table G.10. Combined shoaling/refraction coefficients at Site A for 2-D spectral components using Mitsuyasu spreading function (T_p = 10 s)

SITE A: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	3.3284	6706.7144	11.6174	56773.2062	15088.7407
2	-75	0.6779	1942.6477	4943.6994	4.8971	15.8152
3	-65	0.6983	0.6874	0.7553	1.1752	0.9354
4	-55	0.7879	0.7777	0.7701	0.7655	0.7661
5	-45	0.8491	0.8315	0.8249	0.8226	0.8172
6	-35	0.8902	0.8621	0.8533	0.8497	0.8462
7	-25	0.9142	0.8801	0.8690	0.8610	0.8550
8	-15	0.9218	0.8857	0.8729	0.8653	0.8578
9	-5	0.9227	0.8899	0.8787	0.8715	0.8645
10	5	0.9326	0.9022	0.8923	0.8855	0.0215
11	15	0.9449	0.9192	0.9103	0.9044	0.0254
12	25	0.9524	0.9317	0.9248	0.9195	0.0369
13	35	0.9443	0.9317	0.9263	0.9253	0.1862
14	45	0.9090	0.9118	0.9108	0.9107	0.9123
15	55	0.8505	0.8774	0.8812	0.8748	4.3071
16	65	0.7656	0.7983	0.8220	1.3177	17.3198
17	75	0.6995	1.3233	3061.6829	4.8971	176.8921
18	85	0.6840	3530.0819	18.2559	1276.9652	1246.0559

SITE A: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	18969.6293	2377.3897	1741.4136	547.9799	115.5255
2	-75	3843.2647	2515.9295	884.0095	125.3849	1.6932
3	-65	0.7245	0.7007	0.8601	0.7239	0.9872
4	-55	0.7631	0.7633	0.7732	0.7836	0.8421
5	-45	0.8176	0.8122	0.8103	0.8185	0.8709
6	-35	0.8396	0.8342	0.8293	0.8331	0.8851
7	-25	0.8476	0.8407	0.8328	0.8367	0.8940
8	-15	0.8520	0.8430	0.8356	0.8388	0.9005
9	-5	0.8579	0.8498	0.8423	0.8454	0.9062
10	5	0.8723	0.8647	0.8559	0.8552	0.9120
11	15	0.8922	0.8836	0.8731	0.8687	0.9166
12	25	0.9091	0.9014	0.8906	0.8837	0.9223
13	35	0.9153	0.9096	0.9033	0.8958	0.9265
14	45	0.9144	0.9127	0.9091	0.9048	0.9305
15	55	0.8916	0.9047	0.9027	0.9023	0.9346
16	65	0.8694	0.9163	0.9872	1.1180	1.1919
17	75	2794.7459	2557.9607	17.3454	114.9559	1.5947
18	85	19598.7265	5298.1584	1741.4136	2.4194	247.5665

(KrKs)eff *0.8555*

Table G.11. Combined shoaling/refraction coefficients at Site B for 2-D spectral components using Mitsuyasu spreading function (T_p = 7 s)

SITE B: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	372.4525	4527.7260	13972.4920	35530.4562	18.4378
2	-75	0.1883	2.3203	4.7542	5929.7958	4824.9974
3	-65	0.3510	0.4090	936.4319	2.3376	1.8567
4	-55	0.6630	0.6964	0.7103	0.7184	0.7237
5	-45	0.6752	0.7112	0.7267	0.7410	0.7485
6	-35	0.6802	0.7053	0.7219	0.7316	0.7417
7	-25	0.6942	0.7070	0.7165	0.7257	0.7339
8	-15	0.7224	0.7249	0.7320	0.7370	0.7450
9	-5	0.7640	0.7604	0.7636	0.7671	0.7720
10	5	0.8094	0.8029	0.8033	0.8056	0.8083
11	15	0.8514	0.8433	0.8427	0.8459	0.8446
12	25	0.8843	0.8764	0.8735	0.8731	0.8731
13	35	0.9031	0.8967	0.8961	0.8942	0.8946
14	45	0.8996	0.9052	0.9031	0.9043	0.9050
15	55	0.8631	0.8854	0.8938	0.8925	0.8929
16	65	1.3226	0.9285	11.9947	1.1334	3.5420
17	75	215.2503	7.9634	42.4807	16.9536	12.5788
18	85	74.6635	3510.0011	13277.1037	77.6021	22630.7466

SITE B: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	13060.7372	5.6049	1547.3603	374.3962	86.6995
2	-75	2.1752	5.0447	505.4828	1.1132	2.0812
3	-65	0.7053	0.7163	0.7079	0.7400	0.6191
4	-55	0.7331	0.7530	0.7770	0.8141	0.9403
5	-45	0.7600	0.7759	0.8041	0.8475	0.9629
6	-35	0.7534	0.7740	0.8057	0.8590	0.9745
7	-25	0.7464	0.7649	0.8028	0.8648	0.9824
8	-15	0.7540	0.7715	0.8080	0.8760	0.9860
9	-5	0.7790	0.7930	0.8251	0.8873	0.8875
10	5	0.8133	0.8228	0.8476	0.9003	1.1625
11	15	0.8470	0.8533	0.8715	0.9129	0.9900
12	25	0.8756	0.8787	0.8917	0.9240	0.9911
13	35	0.8939	0.8958	0.9056	0.9319	0.9915
14	45	0.9034	0.9043	0.9143	0.9375	0.9926
15	55	0.8994	0.9059	0.9148	0.9409	0.9932
16	65	1.0165	0.9867	1.0543	1.0190	0.7978
17	75	2.2454	2.0795	10.6843	1.6135	2.6111
18	85	11984.5267	50.3105	13.8894	759.0901	237.4531
(KsKr)eff		*0.8277*				

Table G.12. Combined shoaling/refraction coefficients at Site B for 2-D spectral components using Mitsuyasu spreading function (T_p = 10 s)

SITE B: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	2.5193	5834.4312	11.2855	49675.3380	13990.5401
2	-75	0.5165	1830.3661	4485.2889	4.7487	12.8905
3	-65	0.5317	0.5544	0.7331	1.1396	0.9071
4	-55	0.5999	0.6132	0.6272	0.6452	0.6447
5	-45	0.6573	0.6476	0.6531	0.6589	0.6576
6	-35	0.7101	0.6844	0.6787	0.6766	0.6751
7	-25	0.7584	0.7233	0.7123	0.7051	0.7006
8	-15	0.7966	0.7616	0.7497	0.7417	0.7354
9	-5	0.8321	0.8014	0.7906	0.7843	0.7780
10	5	0.8692	0.8439	0.8346	0.8289	0.0215
11	15	0.9032	0.8824	0.8753	0.8701	0.0254
12	25	0.9266	0.9106	0.9051	0.9000	0.0369
13	35	0.9224	0.9147	0.9121	0.9134	0.1843
14	45	0.8850	0.8911	0.8937	0.8981	0.8971
15	55	0.8240	0.8525	0.8574	0.8639	4.1669
16	65	0.7337	0.7429	0.7998	1.2108	15.0521
17	75	0.6564	1.1795	3061.6829	4.8971	151.8694
18	85	0.5756	3530.0819	16.2644	996.6359	737.6694

SITE B: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	18759.8311	2066.5467	2331.4480	573.3371	114.2005
2	-75	3808.8893	2361.2534	881.8790	120.3242	1.3129
3	-65	0.7038	0.6199	0.7928	0.7038	0.8550
4	-55	0.6422	0.6559	0.6856	0.7381	0.8045
5	-45	0.6641	0.6727	0.3008	0.7460	0.8355
6	-35	0.6741	0.6770	0.6942	0.7373	0.8424
7	-25	0.6961	0.6936	0.6997	0.7315	0.8462
8	-15	0.7297	0.7225	0.7220	0.7427	0.8553
9	-5	0.7717	0.7651	0.7598	0.7709	0.8685
10	5	0.8179	0.8107	0.8041	0.8077	0.8839
11	15	0.8600	0.8535	0.8456	0.8441	0.8995
12	25	0.8926	0.8876	0.8782	0.8735	0.9136
13	35	0.9083	0.9048	0.8990	0.8945	0.9229
14	45	0.8977	0.8987	0.9025	0.9031	0.9291
15	55	0.8689	0.8707	0.8799	0.8973	0.9346
16	65	0.8694	0.9028	0.9349	1.0939	1.1258
17	75	2794.7459	1918.9878	6.1061	190.2092	1.8792
18	85	11903.4461	5298.1584	1741.4136	1.7377	144.0198
(KrKs)eff		*0.7860*				

Table G.13. Combined shoaling/refraction coefficients at Site C for 2-D spectral components using Mitsuyasu spreading function (T_p = 7 s)

SITE C: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	271.6997	3785.8872	11774.7994	29574.4931	16.8109
2	-75	0.1722	2.3203	3.8340	4896.6075	4008.2209
3	-65	0.2057	0.3537	653.0856	1.4875	1.3425
4	-55	0.4171	0.4427	0.4709	0.5007	0.5075
5	-45	0.4730	0.4836	0.5017	0.5191	0.5308
6	-35	0.5372	0.5356	0.5441	0.5532	0.5624
7	-25	0.6105	0.6028	0.6059	0.6114	0.6184
8	-15	0.0658	0.6808	0.6830	0.6861	0.6908
9	-5	0.7640	0.7576	0.7588	0.7611	0.7647
10	5	0.8251	0.8201	0.8204	0.8228	0.8251
11	15	0.8674	0.8629	0.8636	0.8642	0.8653
12	25	0.8905	0.8879	0.8867	0.8879	0.8888
13	35	0.8902	0.8952	0.8961	0.8962	0.8983
14	45	0.8637	0.8819	0.8858	0.8917	0.8936
15	55	0.7860	0.8157	0.8380	0.8490	0.8459
16	65	0.9219	0.7627	7.2013	1.0979	3.7705
17	75	365.0860	9.9685	33.1257	20.6392	13.1257
18	85	2.9449	3510.0011	13277.1037	50.9264	28614.8904

SITE C: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	10414.8534	4.5373	1552.6492	373.8961	72.2993
2	-75	2.1752	3.9664	421.8198	1.0921	3.2584
3	-65	0.6638	0.5947	0.6100	0.6550	0.6212
4	-55	0.5291	0.5662	0.6316	0.7202	0.8976
5	-45	0.5467	0.5778	0.6455	0.7455	0.9318
6	-35	0.5743	0.6009	0.6589	0.7644	0.9551
7	-25	0.6282	0.6479	0.6974	0.7954	0.9716
8	-15	0.6987	0.7147	0.7538	0.8382	0.9820
9	-5	0.7708	0.7831	0.8131	0.8766	0.8769
10	5	0.8291	0.8384	0.8596	0.9060	0.9894
11	15	0.8686	0.8744	0.8898	0.9252	0.9910
12	25	0.8909	0.8947	0.9061	0.9342	0.9911
13	35	0.8992	0.9038	0.9127	0.9383	0.9927
14	45	0.8967	0.9015	0.9120	0.9375	0.9912
15	55	0.8541	0.8606	0.8765	0.9181	0.9898
16	65	0.9750	0.9461	1.0392	0.8815	0.7851
17	75	2.2454	2.4261	9.1435	1.4021	2.3052
18	85	11984.5287	45.3729	18.9079	678.8295	92.7430
(KsKr)eff		*0.8054*				

Table G.14. Combined shoaling/refraction coefficients at Site C for 2-D spectral components using Mitsuyasu spreading function (T_p = 10 s)

SITE C: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	1.7685	4661.8262	10.2897	34958.0498	12415.0240
2	-75	0.4089	1371.7461	3079.1345	4.6008	8.2326
3	-65	0.4005	0.3992	0.7109	1.1040	0.8787
4	-55	0.4819	0.4586	0.4605	0.4702	0.4578
5	-45	0.5649	0.5258	0.5156	0.5540	0.5017
6	-35	0.6445	0.5995	0.5843	0.5751	0.5660
7	-25	0.7161	0.6727	0.6564	0.6455	0.6368
8	-15	0.7735	0.7388	0.7259	0.7170	0.7092
9	-5	0.8263	0.7993	0.7899	0.7843	0.7787
10	5	0.8708	0.8511	0.8441	0.8402	0.0215
11	15	0.9041	0.8873	0.8825	0.8797	0.0254
12	25	0.9132	0.9022	0.8985	0.8966	0.0369
13	35	0.8864	0.8838	0.8854	0.8875	0.1805
14	45	0.8371	0.8470	0.8559	0.8561	0.8590
15	55	0.7782	0.8026	0.8098	0.8201	3.8493
16	65	0.6912	0.6763	0.7776	1.1752	11.3387
17	75	0.6241	0.9781	3061.6829	4.8971	125.7685
18	85	0.4254	3530.0819	13.6090	611.9980	344.4600

SITE C: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	13470.8324	1366.5275	2284.9523	520.6043	118.3411
2	-75	2754.2920	1739.0623	659.0901	103.3876	1.1488
3	-65	0.6624	0.4312	0.5011	0.5670	0.7463
4	-55	0.4382	0.4241	0.4304	0.4954	0.6984
5	-45	0.4939	0.4801	0.4765	0.5163	0.7163
6	-35	0.5545	0.5422	0.5334	0.5546	0.7315
7	-25	0.6269	0.6148	0.6037	0.6160	0.7658
8	-15	0.7015	0.6908	0.6820	0.6899	0.8131
9	-5	0.7724	0.7651	0.7583	0.7644	0.8578
10	5	0.8317	0.8263	0.8213	0.8241	0.8917
11	15	0.8729	0.8690	0.8639	0.8652	0.9136
12	25	0.8937	0.8918	0.8885	0.8888	0.9255
13	35	0.8889	0.8904	0.8947	0.8983	0.9302
14	45	0.8610	0.8624	0.8739	0.8910	0.9291
15	55	0.8085	0.8029	0.8075	0.8240	0.9038
16	65	0.8073	0.8220	0.8451	0.9571	1.0746
17	75	2794.7459	2522.3664	2.2646	244.9262	2.1964
18	85	20099.5639	7751.8681	3173.9874	1.3501	144.0198

(KrKs)eff *0.7726*

Table G.15. Combined shoaling/refraction coefficients at Site D for 2-D spectral components using Mitsuyasu spreading function (T_p = 7 s)

SITE D: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =1 to 5)				
Angle Bands		T_1 = 8.5413s	T_2 = 7.5807s	T_3 = 7.2245s	T_4 = 6.9834s	T_5 = 6.7583s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	239.2222	3377.5863	10410.5770	26142.2158	16.8109
2	-75	0.1722	2.2343	3.2972	4195.0689	3499.4138
3	-65	0.1808	0.3537	534.3428	1.1688	1.1140
4	-55	0.3713	0.3830	0.4150	0.4354	0.4417
5	-45	0.4370	0.4371	0.4498	0.4647	0.4697
6	-35	0.5127	0.5032	0.5082	0.5135	0.5190
7	-25	0.5992	0.5870	0.5871	0.5908	0.5948
8	-15	0.6859	0.6784	0.6790	0.6813	0.6853
9	-5	0.7657	0.7561	0.7629	0.7658	0.7687
10	5	0.8259	0.8252	0.8259	0.8281	0.8312
11	15	0.8665	0.8661	0.8668	0.8682	0.8701
12	25	0.8853	0.8890	0.8889	0.8914	0.8922
13	35	0.8786	0.8906	0.8961	0.8982	0.9002
14	45	0.8328	0.8535	0.8651	0.8708	0.8783
15	55	0.7185	0.7411	0.7741	0.7837	0.7895
16	65	0.6914	0.6411	4.3029	1.0979	3.0564
17	75	215.2503	10.6847	24.1542	19.9021	11.7037
18	85	2.0523	3510.0011	13277.1037	36.3760	26842.6945

SITE D: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 7s, i =6 to 10)				
Angle Bands		T_6 = 6.5001s	T_7 = 6.1304s	T_8 = 5.5518s	T_9 = 4.7819s	T_{10}= 3.4995s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	9079.7771	4.1369	1446.6505	339.0702	78.5767
2	-75	2.1752	3.4273	392.6284	0.9794	10.6683
3	-65	0.6638	0.5271	0.5648	0.5944	0.5617
4	-55	0.4610	0.4982	0.5703	0.6721	0.8584
5	-45	0.4834	0.5108	0.5794	0.6884	0.8937
6	-35	0.5286	0.5497	0.6032	0.7095	0.9248
7	-25	0.6020	0.6170	0.6602	0.7535	0.9522
8	-15	0.6907	0.7042	0.7379	0.8144	0.9710
9	-5	0.7742	0.7852	0.8116	0.8685	0.8683
10	5	0.8353	0.8434	0.8634	0.9052	0.9875
11	15	0.8734	0.8793	0.8940	0.9261	0.9910
12	25	0.8953	0.8989	0.9113	0.9373	0.9922
13	35	0.9027	0.9086	0.9184	0.9434	0.9939
14	45	0.8834	0.8904	0.9076	0.9375	0.9926
15	55	0.7936	0.7926	0.8115	0.8699	0.9795
16	65	0.9335	0.8380	0.9263	0.8006	0.8106
17	75	2.1752	2.5416	5.5030	1.5430	2.1140
18	85	11984.5267	35.3642	19.2605	640.5662	93.7430
(KsKr)eff		*0.8042*				

Table G.16. Combined shoaling/refraction coefficients at Site D for 2-D spectral components using Mitsuyasu spreading function (T_p = 10 s)

SITE D: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =1 to 5)				
Angle Bands		T_1 =12.1982s	T_2 =10.8275s	T_3 =10.3162s	T_4 = 9.9704s	T_5 = 9.6488s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	1.6434	4308.8180	10.2897	32507.6070	12187.3483
2	-75	0.3874	1299.6822	2817.2840	4.6003	7.4743
3	-65	0.3793	0.3881	0.7109	1.1040	0.8787
4	-55	0.4626	0.4387	0.4446	0.4483	0.4391
5	-45	0.5478	0.5051	0.4949	0.4910	0.4789
6	-35	0.6304	0.5840	0.5683	0.5592	0.5472
7	-25	0.7016	0.6611	0.6465	0.6363	0.6267
8	-15	0.7593	0.7298	0.7187	0.7114	0.7044
9	-5	0.8131	0.7914	0.7845	0.7796	0.7760
10	5	0.8593	0.8432	0.8380	0.8349	0.0215
11	15	0.8917	0.8784	0.8745	0.8725	0.0254
12	25	0.8915	0.8843	0.8843	0.8840	0.0369
13	35	0.8606	0.8621	0.8658	0.8696	0.1787
14	45	0.8165	0.8263	0.8318	0.8394	0.8362
15	55	0.7589	0.7777	0.7939	0.7873	3.6250
16	65	0.6699	0.6542	0.7553	1.1752	8.9292
17	75	0.6187	0.9781	6078.6652	4.8971	110.5982
18	85	0.4254	3530.0819	11.9493	411.5300	201.9618

SITE D: 2-D (Mitsuyasu function) Component Transformation Coefficients						
		Frequency Bands (T_p = 10s, i =6 to 10)				
Angle Bands		T_6 = 9.9270s	T_7 = 8.7507s	T_8 = 7.9220s	T_9 = 6.8190s	T_{10}= 4.9906s
Band	Θ_{oj} [°]	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$	$(K_sK_r)_{ij}$
1	-85	12119.7913	1232.8815	2124.0021	461.3618	110.0347
2	-75	2459.6559	1541.2822	565.9385	91.8543	1.0203
3	-65	0.6624	0.4312	0.4263	0.4947	0.6823
4	-55	0.4156	0.3845	0.3771	0.4196	0.6470
5	-45	0.4639	0.4466	0.4348	0.4541	0.6582
6	-35	0.5351	0.5198	0.5050	0.5124	0.6754
7	-25	0.6159	0.6031	0.5893	0.5925	0.7246
8	-15	0.6975	0.6884	0.6795	0.6846	0.7910
9	-5	0.7717	0.7666	0.7620	0.7685	0.8511
10	5	0.8296	0.8270	0.8243	0.8307	0.8926
11	15	0.8689	0.8666	0.8656	0.8696	0.9156
12	25	0.8849	0.8854	0.8875	0.8919	0.9288
13	35	0.8730	0.8759	0.8862	0.8996	0.9351
14	45	0.8376	0.8345	0.8432	0.8669	0.9277
15	55	0.7782	0.7520	0.7390	0.7381	0.8456
16	65	0.7659	0.7411	0.7554	0.8365	0.9723
17	75	2794.7459	2864.8991	0.6542	241.9764	2.0624
18	85	11903.7437	6906.8118	3100.8481	1.2164	144.0198
(KrKs)eff		*0.7638*				

APPENDIX H:

Sample spreadsheets for the combination of two-dimensional spectral components

(note: highlighted cells denote neglected components)

Table H.1. Mean propagation direction calculations for 2-D spectrum using cosine-squared spreading function at Site A (T_p = 7 s)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS							
		Frequency Bands (Tp = 7s, i =1 to 2)					
Angle Bands		T_1 = 8.5413s			T_2 = 7.5807s		
Band	Θ_{oj}[°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]
1	**-85**	5.4635	3.7312	-16.3251	5.2387	3.4305	-21.4025
2	**-75**	0.0237	0.0001	-10.3852	4.2019	2.2070	-22.1813
3	**-65**	0.0289	0.0001	-10.4403	0.0196	5.E-05	-19.1538
4	**-55**	0.0465	0.0003	-7.8358	0.0469	0.0003	-14.7881
5	**-45**	0.0602	0.0005	-2.9550	0.0605	0.0005	-9.2101
6	**-35**	0.0712	0.0006	2.2128	0.0712	0.0006	-3.3069
7	**-25**	0.0794	0.0008	7.4608	0.0791	0.0008	2.6193
8	**-15**	0.0849	0.0009	12.7188	0.0846	0.0009	8.5240
9	**-5**	0.0883	0.0010	18.0527	0.0881	0.0010	14.5182
10	**5**	0.0897	0.0010	23.5473	0.0893	0.0010	20.6937
11	**15**	0.0889	0.0010	29.2751	0.0881	0.0010	27.1039
12	**25**	0.0851	0.0009	35.2655	0.0843	0.0009	33.7862
13	**35**	0.0778	0.0008	41.4759	0.0773	0.0007	40.7197
14	**45**	0.0673	0.0006	47.7000	0.0673	0.0006	47.7779
15	**55**	0.0532	0.0004	53.6599	0.0540	0.0004	54.8280
16	**65**	0.0496	0.0003	55.5029	0.0441	0.0002	57.0888
17	**75**	4.0000	2.0000	56.5147	4.6122	2.6590	57.0414
18	**85**	4.0000	2.0000	56.8152	4.0000	2.0000	56.5684
			0.0091	0.2100		0.0088	0.1807

Table H.1. (Continued)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS							
Angle Bands		Frequency Bands (Tp = 7s, i = 3 to 4)					
		T_3 = 7.2245s			T_4 = 6.9834s		
Band	Θ_{oj}[°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]
1	**-85**	2.1783	0.5931	-12.0250	4.6180	2.6657	-25.2144
2	**-75**	4.2480	2.2557	-22.0231	4.0456	2.0459	-27.0464
3	**-65**	0.0559	0.0004	-18.5167	4.1622	2.1655	-27.7969
4	**-55**	0.0468	0.0003	-17.7880	0.0471	0.0003	-19.9574
5	**-45**	0.0604	0.0005	-11.9276	0.0607	0.0005	-13.8990
6	**-35**	0.0709	0.0006	-5.7194	0.0713	0.0006	-7.4775
7	**-25**	0.0788	0.0008	0.4881	0.0792	0.0008	-1.0499
8	**-15**	0.0843	0.0009	6.6931	0.0847	0.0009	5.3594
9	**-5**	0.0877	0.0010	12.9921	0.0879	0.0010	11.8698
10	**5**	0.0888	0.0010	19.4525	0.0890	0.0010	18.5412
11	**15**	0.0876	0.0010	26.1434	0.0878	0.0010	25.4385
12	**25**	0.0837	0.0009	33.0985	0.0839	0.0009	32.5957
13	**35**	0.0767	0.0007	40.3207	0.0769	0.0007	40.0091
14	**45**	0.0669	0.0006	47.6825	0.0671	0.0006	47.5782
15	**55**	0.0540	0.0004	55.0210	0.0542	0.0004	55.1447
16	**65**	0.0441	0.0002	57.8186	0.0435	0.0002	56.9070
17	**75**	6.2553	4.8911	57.7032	4.5359	2.5718	58.2886
18	**85**	4.0000	2.0000	57.0253	6.2964	3.5065	57.3264
			0.0091	0.1614		0.0088	0.1604

Table H.1. (Continued)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS							
Angle Bands		**Frequency Bands (Tp = 7s, i = 5 to 6)**					
		T_5 = 6.7583s			**T_6 = 6.5001s**		
Band	Θ_{oj}[°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]
1	**-85**	0.0079	8.E-06	-29.5960	4.1136	2.1152	-31.6437
2	**-75**	0.0154	3.E-05	-22.9352	0.0154	3.E-05	-26.7838
3	**-65**	0.0433	0.0002	-29.1774	0.0334	0.0001	-28.9596
4	**-55**	0.0473	0.0003	-22.0762	0.0475	0.0003	-24.6229
5	**-45**	0.0608	0.0005	-15.8291	0.0610	0.0005	-18.1553
6	**-35**	0.0715	0.0006	-9.2093	0.0717	0.0006	-11.2916
7	**-25**	0.0794	0.0008	-2.5707	0.0798	0.0008	-4.4010
8	**-15**	0.0850	0.0009	4.0531	0.0854	0.0009	2.4637
9	**-5**	0.0884	0.0010	10.7566	0.0888	0.0010	9.4193
10	**5**	0.0894	0.0010	17.6483	0.0897	0.0010	16.5655
11	**15**	0.0879	0.0010	24.7477	0.0882	0.0010	23.9124
12	**25**	0.0839	0.0009	32.0938	0.0839	0.0009	31.4859
13	**35**	0.0769	0.0007	39.6916	0.0769	0.0007	39.3040
14	**45**	0.0670	0.0006	47.4609	0.0670	0.0006	47.2938
15	**55**	0.0543	0.0004	55.2417	0.0545	0.0004	55.3184
16	**65**	0.0457	0.0003	57.2516	0.0480	0.0003	57.4176
17	**75**	0.0396	0.0002	57.3395	0.0495	0.0003	57.4866
18	**85**	5.5349	3.8294	57.6778	4.3600	2.3762	57.1377
			0.0091	0.1461		0.0091	0.1408

Table H.1. (Continued)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS							
Angle Bands		Frequency Bands (Tp = 7s, i = 7 to 8)					
		T_7 = 6.1304s			T_8 = 5.5518s		
Band	Θ_{oj}[°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]
1	-85	3.9447	1.9451	-36.4056	2.8240	0.9969	-44.4975
2	-75	0.6831	0.0583	-37.0455	3.7133	1.7236	-41.6178
3	-65	0.0370	0.0002	-32.5449	0.0313	0.0001	-40.3198
4	-55	0.0479	0.0003	-28.4712	0.0488	0.0003	-34.9043
5	-45	0.0615	0.0005	-21.6790	0.0626	0.0005	-27.5734
6	-35	0.0724	0.0007	-14.4618	0.0737	0.0007	-19.7770
7	-25	0.0804	0.0008	-7.1965	0.0820	0.0008	-11.9149
8	-15	0.0862	0.0009	0.0433	0.0880	0.0010	-4.0177
9	-5	0.0896	0.0010	7.4041	0.0917	0.0011	3.9911
10	5	0.0904	0.0010	14.9289	0.0924	0.0011	12.1785
11	15	0.0887	0.0010	22.6407	0.0901	0.0010	20.5138
12	25	0.0843	0.0009	30.5560	0.0853	0.0009	29.0026
13	35	0.0771	0.0007	38.6976	0.0778	0.0008	37.6684
14	45	0.0672	0.0006	47.0223	0.0677	0.0006	46.4872
15	55	0.0546	0.0004	55.4529	0.0552	0.0004	55.4872
16	65	0.0411	0.0002	57.8228	0.0456	0.0003	57.9392
17	75	0.0610	0.0005	58.2685	1.0746	0.1443	57.8511
18	85	1.3696	0.2345	58.6509	1.1677	0.1704	58.5212
			0.0091	0.1210		0.0094	0.0995

Table H.1. (Continued)

SITE A: 2-D (Cosine-Squared Function) NEARSHORE WAVE CHARACTERISTICS							
Angle Bands		Frequency Bands (Tp = 7s, i = 9 to 10)					
		T_9 = 4.7819s			T_{10}= 3.4995s		
Band	Θ_{oj}[°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]	H_{ij} [m]	$H^2_{ij}/8$ [m^2]	Θ_{ij} [°]
1	-85	0.4227	0.0223	-52.0916	2.6110	0.8522	-38.6207
2	-75	0.0514	0.0003	-50.9684	0.0880	0.0010	-37.8928
3	-65	0.0388	0.0002	-47.7001	0.0355	0.0002	-70.8624
4	-55	0.0516	0.0003	-43.7128	0.0594	0.0004	-53.6938
5	-45	0.0655	0.0005	-35.5473	0.0731	0.0007	-43.9635
6	-35	0.0771	0.0007	-26.9352	0.0849	0.0009	-34.2569
7	-25	0.0860	0.0009	-18.2217	0.0941	0.0011	-24.4424
8	-15	0.0925	0.0011	-9.4635	0.1005	0.0013	-14.5684
9	-5	0.0959	0.0011	-0.5169	0.1037	0.0013	-4.6927
10	5	0.0964	0.0012	8.5562	0.1037	0.0013	5.2490
11	15	0.0939	0.0011	17.7310	0.1007	0.0013	15.2152
12	25	0.0884	0.0010	26.9801	0.0945	0.0011	25.1658
13	35	0.0805	0.0008	36.3212	0.0855	0.0009	35.1201
14	45	0.0696	0.0006	45.7813	0.0739	0.0007	45.0809
15	55	0.0567	0.0004	55.2430	0.0600	0.0005	55.0303
16	65	0.0446	0.0002	56.3681	0.0365	0.0002	56.1387
17	75	0.0701	0.0006	53.4400	0.1402	0.0025	64.5561
18	85	5.5692	3.8770	57.6575	0.3582	0.0160	55.8240
			0.0103	0.0590		0.0118	0.0046

m_1	1.2836
m_o	0.0945
Θ_{mean}	13.5782

Table H.2. Shoaling/Refraction coefficient calculations for 2-D spectrum using cosine-sqaured spreading function at Site A (T_p = 7 s)

SITE A: 2-D (Cosine-Squared Function) TRANSFORMATION COEFFICIENT CALCULATIONS											
		Frequency Bands (T_p = 7s, i =1 to 2)									
Angle Bands		T_1 = 8.5413s					T_2 = 7.5807s				
Band	Θ_{oj}[°]	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$
1	-85	0.0001	0.0105	5.4635	520.0274	-	0.0001	0.0105	5.2387	498.8091	-
2	-75	0.0008	0.0275	0.0237	0.8618	0.7427	0.0008	0.0276	4.2019	152.1952	-
3	-65	0.0020	0.0444	0.0289	0.6509	0.4237	0.0020	0.0446	0.0196	0.4398	0.1935
4	-55	0.0036	0.0600	0.0465	0.7750	0.6006	0.0037	0.0603	0.0469	0.7780	0.6052
5	-45	0.0055	0.0739	0.0602	0.8146	0.6636	0.0056	0.0742	0.0605	0.8151	0.6644
6	-35	0.0074	0.0856	0.0712	0.8318	0.6919	0.0075	0.0859	0.0712	0.8286	0.6866
7	-25	0.0091	0.0947	0.0794	0.8384	0.7030	0.0091	0.0950	0.0791	0.8323	0.6927
8	-15	0.0103	0.1009	0.0849	0.8414	0.7080	0.0104	0.1012	0.0846	0.8360	0.6988
9	-5	0.0109	0.1040	0.0883	0.8490	0.7209	0.0110	0.1044	0.0881	0.8439	0.7121
10	5	0.0109	0.1040	0.0897	0.8625	0.7439	0.0110	0.1044	0.0893	0.8554	0.7316
11	15	0.0103	0.1009	0.0889	0.8811	0.7763	0.0104	0.1012	0.0881	0.8706	0.7579
12	25	0.0091	0.0947	0.0851	0.8986	0.8075	0.0091	0.0950	0.0843	0.8870	0.7868
13	35	0.0074	0.0856	0.0778	0.9089	0.8261	0.0075	0.0859	0.0773	0.8996	0.8093
14	45	0.0055	0.0739	0.0673	0.9107	0.8294	0.0056	0.0742	0.0673	0.9067	0.8222
15	55	0.0036	0.0600	0.0532	0.8867	0.7862	0.0037	0.0603	0.0540	0.8957	0.8023
16	65	0.0020	0.0444	0.0496	1.1171	1.2480	0.0020	0.0446	0.0441	0.9896	0.9794
17	75	0.0008	0.0275	4.0000	145.4545	-	0.0008	0.0276	4.6122	167.0565	-
18	85	0.0001	0.0105	4.0000	380.9524	-	0.0001	0.0105	4.0000	379.3377	-
		0.0010				0.0734	0.0018				0.0715

Table H.2. (Continued)

SITE A: 2-D (Cosine-Squared Function) TRANSFORMATION COEFFICIENT CALCULATIONS											
		Frequency Bands (T_p = 7s, i =3 to 4)									
Angle Bands		T_3 = 7.2245s					T_4 = 6.9834s				
Band	Θ_{oj}[°]	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$
1	-85	0.0001	0.0105	2.1783	207.4571	-	0.0001	0.0105	4.6180	438.6873	-
2	-75	0.0008	0.0275	4.2480	154.5077	-	0.0008	0.0276	4.0458	148.7826	-
3	-65	0.0020	0.0444	0.0559	1.2597	1.5868	0.0020	0.0445	4.1622	93.5602	-
4	-55	0.0036	0.0600	0.0468	0.7796	0.6077	0.0037	0.0602	0.0471	0.7826	0.6125
5	-45	0.0055	0.0739	0.0604	0.8172	0.6678	0.0056	0.0741	0.0607	0.8192	0.6711
6	-35	0.0074	0.0855	0.0709	0.8292	0.6876	0.0074	0.0858	0.0713	0.8312	0.6909
7	-25	0.0091	0.0946	0.0788	0.8326	0.6933	0.0091	0.0949	0.0792	0.8348	0.6969
8	-15	0.0103	0.1008	0.0843	0.8363	0.6994	0.0103	0.1011	0.0847	0.8378	0.7019
9	-5	0.0109	0.1040	0.0877	0.8433	0.7111	0.0110	0.1042	0.0879	0.8436	0.7116
10	5	0.0109	0.1040	0.0888	0.8538	0.7291	0.0110	0.1042	0.0890	0.8541	0.7295
11	15	0.0103	0.1008	0.0876	0.8690	0.7552	0.0103	0.1011	0.0878	0.8684	0.7542
12	25	0.0091	0.0946	0.0837	0.8844	0.7822	0.0091	0.0949	0.0839	0.8843	0.7820
13	35	0.0074	0.0855	0.0767	0.8971	0.8047	0.0074	0.0858	0.0769	0.8965	0.8036
14	45	0.0055	0.0739	0.0669	0.9051	0.8192	0.0056	0.0741	0.0671	0.9056	0.8201
15	55	0.0036	0.0600	0.0540	0.8995	0.8091	0.0037	0.0602	0.0542	0.9006	0.8111
16	65	0.0020	0.0444	0.0441	0.9938	0.9876	0.0020	0.0445	0.0435	0.9778	0.9561
17	75	0.0008	0.0275	6.2553	227.5169	-	0.0008	0.0276	4.5359	164.5717	-
18	85	0.0001	0.0105	4.0000	380.9524	-	0.0001	0.0105	5.2964	503.1319	-
		0.0018				0.0736	0.0038				0.0708

Table H.2. (Continued)

SITE A: 2-D (Cosine-Squared Function) TRANSFORMATION COEFFICIENT CALCULATIONS											
Angle Bands		Frequency Bands (T_p = 7s, i = 5 to 6)									
		T_5 = 6.7583 s					T_6 = 6.5001 s				
Band	Θ_{oj}[°]	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$
1	-85	0.0001	0.0105	0.0079	0.7500	0.5625	0.0001	0.0105	4.1136	390.3887	-
2	-75	0.0008	0.0276	0.0154	0.5584	0.3118	0.0008	0.0276	0.0154	0.5582	0.3116
3	-65	0.0020	0.0445	0.0433	0.9727	0.9462	0.0020	0.0445	0.0334	0.7501	0.5626
4	-55	0.0037	0.0602	0.0473	0.7855	0.6170	0.0037	0.0602	0.0475	0.7885	0.6217
5	-45	0.0056	0.0741	0.0608	0.8201	0.6725	0.0056	0.0741	0.0610	0.8232	0.6777
6	-35	0.0075	0.0858	0.0715	0.8330	0.6939	0.0075	0.0858	0.0717	0.8357	0.6983
7	-25	0.0091	0.0949	0.0794	0.8364	0.6995	0.0091	0.0949	0.0798	0.8409	0.7071
8	-15	0.0103	0.1011	0.0850	0.8408	0.7069	0.0104	0.1012	0.0854	0.8439	0.7121
9	-5	0.0110	0.1043	0.0884	0.8476	0.7185	0.0110	0.1043	0.0888	0.8515	0.7250
10	5	0.0110	0.1043	0.0894	0.8572	0.7348	0.0110	0.1043	0.0897	0.8601	0.7397
11	15	0.0103	0.1011	0.0879	0.8694	0.7559	0.0104	0.1012	0.0882	0.8715	0.7596
12	25	0.0091	0.0949	0.0839	0.8838	0.7811	0.0091	0.0949	0.0839	0.8841	0.7816
13	35	0.0075	0.0858	0.0769	0.8959	0.8027	0.0075	0.0858	0.0769	0.8963	0.8033
14	45	0.0056	0.0741	0.0670	0.9037	0.8167	0.0056	0.0741	0.0670	0.9042	0.8175
15	55	0.0037	0.0602	0.0543	0.9017	0.8131	0.0037	0.0602	0.0545	0.9047	0.8185
16	65	0.0020	0.0445	0.0457	1.0267	1.0540	0.0020	0.0445	0.0480	1.0779	1.1620
17	75	0.0008	0.0276	0.0396	1.4359	-	0.0008	0.0276	0.0495	1.7943	-
18	85	0.0001	0.0105	5.5349	525.4601	-	0.0001	0.0105	4.3600	413.7728	-
		0.0009				0.0735	0.0010				0.0735

Table H.2. (Continued)

SITE A: 2-D (Cosine-Squared Function) TRANSFORMATION COEFFICIENT CALCULATIONS											
		Frequency Bands (T_p = 7s, i = 7 to 8)									
Angle Bands		T_7 = 6.1304 s					T_8 = 5.5518 s				
Band	Θ_{oj}[°]	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$
1	**-85**	0.0001	0.0105	3.9447	374.4599	-	0.0001	0.0105	2.8240	268.4578	-
2	**-75**	0.0008	0.0276	0.6831	24.7665	-	0.0008	0.0275	3.7133	134.8209	-
3	**-65**	0.0020	0.0445	0.0370	0.8311	0.6907	0.0020	0.0444	0.0313	0.7050	0.4970
4	**-55**	0.0037	0.0602	0.0479	0.7953	0.6326	0.0037	0.0601	0.0488	0.8114	0.6584
5	**-45**	0.0056	0.0741	0.0615	0.8294	0.6879	0.0055	0.0740	0.0626	0.8454	0.7148
6	**-35**	0.0075	0.0858	0.0724	0.8434	0.7113	0.0074	0.0857	0.0737	0.8598	0.7392
7	**-25**	0.0091	0.0949	0.0804	0.8468	0.7171	0.0091	0.0948	0.0820	0.8649	0.7481
8	**-15**	0.0104	0.1011	0.0862	0.8526	0.7270	0.0103	0.1010	0.0880	0.8713	0.7591
9	**-5**	0.0110	0.1043	0.0896	0.8591	0.7381	0.0110	0.1042	0.0917	0.8800	0.7745
10	**5**	0.0110	0.1043	0.0904	0.8668	0.7513	0.0110	0.1042	0.0924	0.8868	0.7863
11	**15**	0.0104	0.1011	0.0887	0.8773	0.7697	0.0103	0.1010	0.0901	0.8921	0.7958
12	**25**	0.0091	0.0949	0.0843	0.8879	0.7884	0.0091	0.0948	0.0853	0.8997	0.8095
13	**35**	0.0075	0.0858	0.0771	0.8982	0.8067	0.0074	0.0857	0.0778	0.9076	0.8237
14	**45**	0.0056	0.0741	0.0672	0.9063	0.8213	0.0055	0.0740	0.0677	0.9143	0.8360
15	**55**	0.0037	0.0602	0.0546	0.9066	0.8219	0.0037	0.0601	0.0552	0.9179	0.8425
16	**65**	0.0020	0.0445	0.0411	0.9232	0.8523	0.0020	0.0444	0.0456	1.0270	1.0548
17	**75**	0.0008	0.0276	0.0610	2.2116	-	0.0008	0.0275	1.0746	39.0181	-
18	**85**	0.0001	0.0105	1.3696	130.0125	-	0.0001	0.0105	1.1677	111.0050	-
		0.0018				0.0738	0.0018				0.0761

Table H.2. (Continued)

SITE A: 2-D (Cosine-Squared Function) TRANSFORMATION COEFFICIENT CALCULATIONS											
Angle Bands		Frequency Bands (T_p = 7s, i = 9 to 10)									
		T_9 = 4.7819 s					T_{10}= 3.4995 s				
Band	Θ_{oj}[°]	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$	ΔE_{ij}	Hmo_{ij} [m]	H_{ij} [m]	KsKr	$(KsKr)^2$
1	-85	0.0001	0.0105	0.4227	40.1490	-	0.0001	0.0106	2.6110	247.0840	-
2	-75	0.0008	0.0276	0.0514	1.8647	-	0.0008	0.0277	0.0880	3.1804	-
3	-65	0.0020	0.0445	0.0388	0.8721	0.7605	0.0020	0.0446	0.0355	0.7960	0.6336
4	-55	0.0037	0.0602	0.0516	0.8573	0.7349	0.0037	0.0604	0.0594	0.9832	0.9666
5	-45	0.0056	0.0741	0.0655	0.8839	0.7813	0.0056	0.0744	0.0731	0.9827	0.9658
6	-35	0.0074	0.0858	0.0771	0.8987	0.8076	0.0075	0.0861	0.0849	0.9859	0.9720
7	-25	0.0091	0.0949	0.0860	0.9063	0.8215	0.0092	0.0952	0.0941	0.9880	0.9761
8	-15	0.0103	0.1011	0.0925	0.9149	0.8371	0.0104	0.1015	0.1005	0.9901	0.9804
9	-5	0.0110	0.1042	0.0959	0.9203	0.8470	0.0111	0.1046	0.1037	0.9914	0.9829
10	5	0.0110	0.1042	0.0964	0.9251	0.8559	0.0111	0.1046	0.1037	0.9914	0.9829
11	15	0.0103	0.1011	0.0939	0.9288	0.8626	0.0104	0.1015	0.1007	0.9921	0.9843
12	25	0.0091	0.0949	0.0884	0.9316	0.8679	0.0092	0.0952	0.0945	0.9922	0.9844
13	35	0.0074	0.0858	0.0805	0.9383	0.8804	0.0075	0.0861	0.0855	0.9929	0.9858
14	45	0.0056	0.0741	0.0696	0.9392	0.8821	0.0056	0.0744	0.0739	0.9935	0.9870
15	55	0.0037	0.0602	0.0567	0.9420	0.8874	0.0037	0.0604	0.0600	0.9931	0.9862
16	65	0.0020	0.0445	0.0446	1.0024	1.0049	0.0020	0.0446	0.0365	0.8184	0.6698
17	75	0.0008	0.0276	0.0701	2.5431	-	0.0008	0.0277	0.1402	5.0870	-
18	85	0.0001	0.0105	5.5692	528.9758	-	0.0001	0.0106	0.3582	33.8944	-
		0.0018				0.0829	0.0018				0.0957

***(KrKs)$_{eff}$* 0.8746 SITE A (Tp = 7s)**

Neglected ΔE 0.0162 1.62 %

Vita

Regina Irene Williams was born in Leonardtown, Maryland, May 28, 1980. Her parents, Donato and Irene Williams, currently live in Prince Frederick, Maryland.

Regina graduated from Carnegie Mellon University in Pittsburgh, Pennsylvania on May 19, 2002. She graduated with a Bachelor of Science degree with a major in Civil Engineering and a minor in Environmental Engineering.

In the fall of 2002, Regina enrolled at Lehigh University to pursue graduate studies in the field of Coastal and Hydraulic Engineering within the Civil Engineering Department. This project was submitted as a part of her Master of Science degree in Civil Engineering from Lehigh University.

END OF
TITLE